TRANSACTIONS

OF THE

ROYAL SOCIETY

OF

NEW SOUTH WALES,

FOR THE YEAR 1868.

SYDNEY:
F. WHITE, MACHINE PRINTER, WILLIAM STREET.

1869.

ROYAL SOCIETY

OF NEW SOUTH WALES.

OFFICERS FOR 1868.

President:

HIS EXCELLENCY THE RIGHT HON. THE EARL OF BELMORE.

Vice-Presidents:

REV. W. B. CLARKE, M.A., F.G.S.

G. R. SMALLEY, ESQ., B.A., F.R.A.S.

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EDWARD BEDFORD, ESQ

Honorary Secretaries:

PROFESSOR PELL, B.A.

REV. WILLIAM SCOTT, M.A.

Council:

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DR. FORTESCUE

GERARD KREFFT, ESQ.

CHARLES MOORE, ESQ.

CHRISTOPHER ROLLESTON, ESQ.

PROFESSOR SMITH, M.D.

FUNDAMENTAL RULES.

Object of the Society.

1. The object of the Society is to receive at its stated meetings original papers on subjects of Science, Art, Literature, and Philosophy, and especially on such subjects as tend to develope the resources of Australia, and to illustrate its Natural History and Productions.

President.

2. The Governor of New South Wales shall be *ex officio* the President of the Society.

Other Officers.

3. The other Officers of the Society shall consist of two Vice-Presidents, a Treasurer, and two or more Secretaries, who, with six other Members, shall constitute a Council for the management of the affairs of the Society.

Election of Officers.

4. The Vice-Presidents, Treasurer, Secretaries, and the six other Members of Council shall be elected annually at a General Meeting in the month of May.

Vacancies during the Year.

5. Any vacancies occurring in the Council of Management during the year, may be filled up by the Council.

Fees.

6. The entrance money paid by Members on their admission shall be One Guinea; and the annual subscription shall be One Guinea, payable in advance.

The sum of Ten Pounds may be paid at any time as a composition for the ordinary annual payment for life.

Honorary Members.

7. The Honorary Members of the Society shall be persons who have been eminent benefactors to this or some other of the Australian Colonies, or distinguished patrons and promoters of the objects of the Society. Every person proposed as an Honorary Member must be recommended by the Council and elected by the Society. Honorary Members shall be exempted from payment of fees and contributions, they may attend the meetings of the Society, and they shall be furnished with copies of transactions, and proceedings, published by the Society, but they shall have no right to hold office, to vote, or otherwise interfere in the business of the Society.

Confirmation of Bye-Laws.

8. Bye-Laws proposed by the Council of Management shall not be binding until ratified by a General Meeting.

Alteration of Fundamental Rules.

9. No alteration of or addition to the Fundamental Rules of the Society shall be made, unless carried at two successive General Meetings.

BYE-LAWS.

Ordinary Meetings.

1. An Ordinary Meeting of the Royal Society, to be convened by Public Advertisement, shall take place at 8 p m., on the first Wednesday in every month, during the last eight months of the year. These Meetings will be open for the reception of contributions, and the discussion of subjects of every kind, if brought forward in conformity with the Fundamental Rules and Bye-Laws of the Society.

Council Meetings.

2. Meetings of the Council of Management shall take place on the last Wednesday in every month, and on such other days as the Council may determine.

Contributions to the Society.

3. Contributions to the Society of whatever character, must be sent to one of the Secretaries, to be laid before the Council of Management. It will be the duty of the Council to arrange, for promulgation and discussion at an Ordinary Meeting, such communications as are suitable for that purpose, as well as to dispose of the whole in the manner best adapted to promote the objects of the Society.

4. Candidates for admission as Ordinary Members to be proposed and seconded at one of the stated meetings of the Society. The vote on their admission to take place, by ballot, at the next subsequent meeting; the assent of the majority of the Members voting at the latter meeting being requisite for the admission of the Candidate.

New Members to be notified of their Election.

5. Every Member shall receive due notification of his election, together with a Copy of the Fundamental Rules and Bye-Laws of the Society.

Introduction of New Members to the Society.

6. Every Candidate duly elected as Member should, on his first attendance at a Meeting of the Society, be introduced to the Chair, by his proposer, or seconder, or by some person acting on their behalf.

Annual Subscriptions, when due.

7. Annual Subscriptions shall become due on the first of May for the year then commencing. The Entrance Fee and first year's Subscription of a New Member shall become due on the day of his election.

Members whose Subscriptions are not paid to enjoy no privileges.

8. Members will not be entitled to attend the Meetings or to enjoy any of the privileges of the Society until their Entrance Fee and Subscription for the year have been paid.

Subscriptions in arrears.

9. Members who have not paid their Subscriptions for the current year, shall be informed of the fact by the Treasurer. If, thirty days after such intimation, any are still indebted, their names will be formally laid before the Society at the first Ordinary Meeting. At the next Ordinary Meeting, those whose Subscriptions are still due, will be considered to have resigned.

Expulsion of Members.

10. A majority of Members present at any Ordinary Meeting, shall have power to expel an obnoxious Member from the Society, provided that a resolution to that effect has been moved and seconded at the previous Ordinary Meeting, and that due notice of the same has been sent in writing to the Member in question, within a week after the Meeting at which such resolution has been brought forward.

Admission of Visitors.

11. Every Ordinary Member shall have the privilege of admitting one friend as a Visitor to an Ordinary Meeting of the Society, on the following conditions :—

1. That the name and residence of the Visitor, together with the name of the Member introducing him, be entered in a book at the time.
2. That the Visitor does not permanently reside within ten miles of Sydney, and,
3. That he shall not have attended two meetings of the Society in the current year.

The Council shall have power to introduce Visitors, irrespective of the above restrictions.

Management of Funds.

12. The Funds of the Society shall be lodged at a Bank, named by the Council of Management. Claims against the Society, when approved by the Council, shall be paid by the Treasurer.

Audit of Accounts.

13 Two Auditors shall be appointed annually at an Ordinary Meeting to Audit the Treasurer's Accounts. The Accounts as audited to be laid before the Annual Meeting in May.

LIST OF MEMBERS

OF THE

Royal Society of New South Wales.

Adams, P. F. Surveyor-General.
Allen, George, the Hon., M.L.C., Toxteth Park, Glebe.
Allen, George Wigram, Elizabeth-street.
Allen, A. Elizabeth-street.
Allwood, Rev. R., King-street.
Armstrong, Walter Dickinson, Macquarie-street.
Ashdown, A., Department of Works, Phillip-street,
Allerding, F., Hunter-street.

Barnet, James, Colonial Architect.
Bedford, Edward, Castlereagh-street.
Beg, Rev. Dr., Crown.street.
Beilby, E. T. Macquarie-street.
Belinfante, Dr., Elizabeth-street.
Belisario, Dr., Lyons' Terrace.
Bell, William, Pitt-street.
Belmore, His Excellency the Right Hon., the Earl of
Bensusan, S. L., George Street.
Berry, Alexander, North Shore.
Bode, Rev. G., Macquarie Street.
Boyd, Dr., Lyons' Terrace.
Brereton, Dr., O'Connell-street.

Campbell, Charles, Pine Villa, Newtown.
Clarke, Rev. W. B., St. Leonard's, North Shore.
Cox, Dr. James, Phillip-street.
Cracknell, E. C., Telegraph Office, George-street,
Cronin, J. D., Darling-street, Balmain.
Creed, Dr. Mildred, Scone,

De Lissa, Alfred, Pitt-street.
Deffell, G. H., Elizabeth-street.
Docker, Joseph, the Hon., M.L.C., Australian Club.
Duncan, W. A., Custom House.

Elliott, F. W., Pitt Street.

Fairfax, John, *Herald* Office.
Fairfax, J. R., *Herald* Office.
Flavelle, John, George-street.
Forster, R. M., York-street.
Fortescue, Dr., Elizabeth-street.
Francis, Judge.
Franck, S. Pitt-street.

Gardiner, Martin, C. E , Gordon Terrace, Liverpool-street, East.
Garran, Andrew, Phillip-street.
Goodlet, J., 124, Erskine-street.
Gowland, John, R. N , North Shore.
Goodchap, Charles, Civil Service Club.
Graham, Rev. James.
Gray, Samuel W., Wollumben, Tweed River, *via* Cassino.

Halloran, Henry, Colonial Secretary's Office.
Hill, Edward, Rose Bay. (Life.)
Holden, G. K., Land Titles' Office,
Holt, the Hon. Thomas, M.L.C., The Warren, near Sydney.
Hordern, A , Darling Point.
Hovell, Captain, Goulburn.
Hunt, Robert, Royal Branch Mint.

Jacques, T. J., Registrar-General.
Jones, Dr. Sydney, College-street,
Josephson, Judge, King-street.

Krefft, Gerard, Museum, College-street.

Lang, Rev. Dr., J. D., Jamieson-street.
Leibius, Dr. Adolph, Royal Branch Mint.
Lord, Francis, the Hon. M.L C., North Shore.

Macarthur, the Hon., Sir William, M.L.A.
Manning, John Edye
Mansfield, G. A., Pitt-street.
Mayes, Charles, Pitt-street.
McDonnell, William J., George-street.
McDonnell, William, George-street.

Metcalfe, M., Bridge-street.
Miles, Charles, Miles' Buildings, George-street.
Miller, F., Royal Branch Mint.
Mitchell, D. P., Cumberland-street.
Mitchell, James Sutherland, Tooth's Brewery, Parramatta-street.
Morehead, R. A. A., 30, O'Connell-street.
Moore, Charles, Director of the Botanic Gardens.
Morrell, E. A. Phillip-street.
Mort, Thomas S., Pitt-street.
Murnin, M. E., Exchange, Bridge-street.
Murray, Sir T. A., President of the Legislative Council.

Nathan, Charles, Macquarie-street.

O'Brien, Dr., Burwood.

Paterson, Dr., Elizabeth-street, North.
Paterson, Hugh. 344, George-street.
Pell, Professor, Sydney University.
Phillips, Captain, Pacific Insurance Company, Pitt-street.
Prince, Henry, George-street.
Prout, Victor, Castlereagh-street.

Ramsay, Edward, (life) Dobroyd.
Reading, E., Phillip-street.
Roberts, J,, George-street.
Roberts, Alfred, Castlereagh-street.
Roberts, Major, Double Bay.
Richards, Thomas, Government Printing Office.
Rolleston, Christopher, Auditor-General.
Ross, J. G., 193, Macquarie-street.
Russell, Henry, Sydney Observatory.
Reed, Howard, Pott's Point.

Scott, Rev. William, (life) Warden of St. Paul's College.
Scott, Montague, George-street.
Scott, J. H. L., Civil Service Club.
Senior, F., George-street.
Smalley, G. R., Government Astronomer.
Smith, Professor, M.D., Sydney University.

Tebbutt, John, Junr., Windsor.
Thorne, George, Junr.
Tornaghi, A., George-street.
Thomson, E. Deas, the Hon., M.L.C., C.B.
Thomson, Dr., Sydney University.
Thompson, James, Treasury.

Tooth, Frederick, Parramatta-street.
Tucker, William, Clifton, North Shore.
Twynam, E., Goulburn.

Walker, William, M.P., Windsor.
Ward, R. D., North Shore.
Watt, Charles, Burwood.
Walker, P. B., Telegraph Office, George-street.
Weigall, A. B., Head Master, Sydney Grammar School.
Williams, Dr., Macquarie-street.
Williams, J. P., New Pitt-street
Windeyer, W. C., M.L.A., Elizabeth-street.

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CORRIGENDA.

Page 74, line 19, *for* "vibrition," *read* "vibration."

Page 79, line 23, *before* "Australia," *insert* "and beyond."

Page 81, line 29, *for* "writes," *read* "write."

Page 82, line 18, *after* "spoken," *insert* "of."

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TRANSACTIONS

OF THE

Royal Society of New South Wales.

Opening Address to the Royal Society, delivered at its first meeting, 3rd June, 1868, by G. R. Smalley, Esq., B.A., F.R.A.S., Vice-President.

My Lord, Ladies and Gentlemen,—Although this is the commencement of the second session of the Royal Society of New South Wales, yet it is the first occasion since the present title has been granted to us that we have had the pleasure of meeting, in a social manner, so many who, without being members of the society, are, we hope, not uninterested in its success and progress.

It is the ordinary custom in such societies as this, for one of its principal officers to deliver an address at the opening meeting of each session.

This year that duty has devolved upon myself, and I could most sincerely have wished that it had been undertaken by some one more fitted for the occasion. But the society having done me the honour to elect me as one of their Vice-Presidents, and my respected friend and colleague, the senior Vice-President desiring to be relieved from the duty of delivering the address in two suc-

cessive years, there was no alternative for me but to accede to the request of the council and use my best endeavours, though I fear very inadequately, to acknowledge the honour conferred upon me.

Let me then crave your patience whilst I offer, in the first place, some remarks upon the utility of this society; and it may not be irrelevant if I briefly refer to the advantages which may be derived from societies in general.

From very early ages we find that societies were formed for the advancement of religion, science, art, and literature. From Chinese records it appears that about 600 years before the Christian Era a Mathematical Board was established especially for the improvement of astronomical science.

In modern times, hardly a year has passed by without the establishment of some new society for the promotion of missionary enterprise, the advancement of useful arts and science, or the reform of abuses. And why is this combined action so essential and powerful? It is because "union is strength." As in a bundle of faggots one may be insufficient for any important work, yet when all are firmly united together, the bundle may help to support a line of rails over which rolls the heavy locomotive. Some of the objects and advantages of learned societies is to encourage and bring forward those who have conceived some new theory, or made some new discovery, to afford opportunities to the author for having the truth and utility of the same discussed and examined, and in many cases to reward him with some especial mark of distinction.

The advantages are obvious. It not only contributes to the advancement of knowledge generally, but the opportunity for discussion increases the confidence of an author in the truth and value of those researches to which he has devoted so much time and labour. The amount of real practical good that has been effected by the Society of Arts; the British Association; the Microscopical Society; the Geographical Society; the Zoological Society, and many others, is too well known to need much comment. Where but for them would be the improvements in the steam engine; the progress of Meteorology; the discoveries in Africa; and our extensive knowledge of the mineral and vegetable kingdoms? Where but through their united influence would

have been the Great Exhibition of 1851, which seems to have set all nations in motion, enjoying an international intercourse previously unknown, and with friendly emulation striving for progress and improvement.

I do not mean to affirm that the patronage and assistance of a society is indispensable to success. We know that many great and valuable discoveries have been made and perfected without any assistance whatever beyond the perseverance and means of the originator. On the other hand is there not many a solitary, unintrusive individual who may possess all the elements of success, but for want of interest, capital, or assurance, his talents and knowledge are constrained to lie under a bushel, and ideas or discoveries which might have benefited mankind, remain to be adopted or propounded by some one more fortunate than himself—

> "Full many a flower is born to blush unseen
> And waste its sweetness in the desert air."

I do not know what is the exact number of societies on the Continent and in America, but at the present time there are in London alone, no fewer than sixty-two, separately working for the advancement of some particular branch of knowledge, each sailing under a different colour, but all having one common object in view—the happiness and welfare of mankind. Most of these societies may be said to derive their existence from one common stock, and it is natural that it should be so, when we consider that every branch of natural and physical science forms but a part of a great whole—the science of the universe; to employ the appropriate, but oft-quoted language of Francis Bacon—"No natural phenomenon can be adequately studied in itself alone, but to be understood, it must be considered as it stands connected with all nature."

But, however expedient it may be that there should be distinct and independent scientific communities, it is evident that such a disintegration can only take place with advantage in a large metropolis where lovers of science with adequate means abound; and where little bands of congenial minds prefer meeting together for discussing their favourite study at any time, rather than trust to an occasional opportunity for doing so at a meeting of a society more general in its objects. In young communities, a society such as this is the only one likely to be effectual in promoting

the advancement of art and science with an energy adequate to meet the requirements of the times.

The first idea of learned societies is believed to have originated with the illustrious Bacon, who depicted a scheme to establish a society for the maintenance and promotion of science in a philosophical romance entitled "*The New Atlantis.*" It appears, however, that the first learned society actually founded in London was by Archbishop Parker, in 1572, for the preservation of ancient documents.

Great things grow out of small beginnings. In the year 1600, a few gentlemen including such names as Boyle, Evelyn, Hook, and Cowley, used to meet together at the Bull's Head Tavern, Cheapside, London, partly to study science for its own sake, and also to avoid the distraction of civil war. From such a small beginning sprang the Royal Society of London—a society whose reputation, influence, and usefulness, is co-extensive with the limits of science.

It is curious to learn from the history of this society the subjects which were discussed by men of renowned genius, and sincerely earnest in the pursuit of practical knowledge. We find discussed such subjects as witchcraft, the virtue of the divining rod, and the touching for the evil. On the other hand, we learn that pendulum experiments were introduced by Sir Christopher Wren; the air-pump, by Boyle; and certain experiments to determine the weight of the atmosphere at different heights above the earth's surface. Of so much practical value was the society considered, that during the first century of its establishment there was a law enacted that all new inventions, mechanical or otherwise, should be approved by it before a patent was granted.

The Philosophical Transactions of the Royal Society were first published in 1664. Some of the papers are singularly worded. There are papers on "Optick Glasses at Rome; Observations on Jupiter; Endeavours towards a History of Cold; to find the Longitude by Clock Machinery; and a relation of a very odd monstrous Calf." In 1865 we find a paper on "The transfusion of Blood from one living animal to another"; but it need hardly be observed that the principle of vital energy was not to be restored on such easy terms.

Yet these proceedings, eccentric as they appear to us now, formed the germ of a great progressive movement, which has resulted in the present high state of art and science.

About the year 1687, the Royal Society induced the Government to establish the Royal Observatory of Greenwich, and Flamstead was appointed first astronomer royal. About the same time also, Sir Isaac Newton communicated to the society a description of his reflecting telescope, which was the first ever made, and still remains the property of that body. Then comes the discovery of Papin's Digester for the economical preparation of food from meat, and the bones and other parts of it, otherwise unserviceable.

In 1683, the plan of colouring maps, so as to represent different geological strata, was brought out under the same auspices; and in 1699, Savery exhibited at a meeting of the society a model of his steam engine, which, with all its roughness, was the foundation of the greatest of all modern mechanical achievements.

To the influence exerted by the Royal Society is due the fitting-out of an expedition under Captain Cook to the South Seas, for the purpose of observing the transit of Venus across the sun's disk, in 1769—the only really accurate method by which the distance of the Earth from the Sun can be determined. In 1774, the Royal Society established a series of meteorological observations, and continued the same till 1843, when it became part of the work of the Observatory of Greenwich.

Subsequently to this, the world was enlightened through the same medium, by Herschel's discovery of Uranus; the discovery of the composition of water by Priestly; the first attempt at a Trigonometrical Survey of England, by Roy; the Undulatory Theory of Light, by Dr. Young; the Rise of Geology as a Science; and the celebrated machine of Babbage, for calculating and printing mathematical tables, and solution of mathematical formulæ generally.

Later still such subjects as these have been investigated: the best form for ships; the attraction of iron on the ship's compass; the tides; and that wonderful discovery, the Spectrum Analysis, by which we can determine the material of which a star is composed.

Till the year 1842, little was known of the laws of meteorology

and magnetism, and but little or no attempt had been made to reduce them to a science; indeed there was not sufficient data for the purpose. But in that year the Society prevailed upon the British Government to fit out expeditions, and establish magnetical and meteorological observatories in all parts of the world. And the valuable results obtained were well worth the enormous expense incurred. So important do I consider those sciences to be, that they occupy a very considerable portion of the means and very limited force of the Sydney Observatory. And here, an extract from the leading article of the *Sydney Morning Herald*, of Monday last, is not inappropriate. The writer, speaking of meteorology, says:—"The study is a very fascinating one—we might almost say, a fashionable one—and many efforts have been put forth to make it popular by explaining its scientific complexities. Among the minds devoted to its study, some are more patient in the observation of facts, some more eager in the formation of hypotheses."

To the Royal Society may be trăced the rise and progress of that most wonderful discovery, the Electric Telegraph. This evening there will be an opportunity of witnessing some most important experiments made with apparatus of the most beautiful and novel description, which have recently been received from England by the Superintendent of Telegraphs.

Time would fail to tell of the amount of good which has been effected, directly or indirectly, by the Royal Society of London. From it emanated the British Association for the Advancement of Science—an association which for a long time met with the most bitter opposition from a portion of the London Press, including the *Times*, but has produced no inconsiderable influence upon the welfare of mankind.

In tracing the progress and history of the Royal Society of England, my object has been to establish the position that such a society is calculated to be productive of great general benefit to mankind. And if so in the old country, will it not be so in a young one? England, the land we all call Home, has obtained her exalted position amongst nations in a great measure through the perfection she has attained in the arts and sciences. Macaulay, who foresees the New Zealander standing on the ruins of London Bridge, may tell us, indeed, that when a nation arrives at the

highest point of perfection in mechanical art, its political greatness declines—but we have yet to see this ill omen verified; and, if it should be so, most assuredly other nations, sprung from the parent tree, will rise up to take their part in the regeneration of the world.

It is with some such ideas as these that I endeavour to impress upon this assembly the advantages of the Royal Society of New South Wales.

The society needs no defence, and my object is to explain its object and advantages, rather than defend an institution which requires no defence. The Royal Society does not wish to arrogate to itself any undue importance, but it earnestly desires to be instrumental in drawing forth the resources of the colony, and carry out the motto, "Advance Australia." We would gladly receive amongst us professors or students of any branch of knowledge admissible for discussion. The theoretical man and practical man are equally welcome. And though we desire to have those who will take an active, lively part in our work, yet are we glad to receive others who may take but an occasional interest in the subjects brought before us. They may not be prepared to read papers, or be punctual in their attendance, but they may often do good service by bringing forward some fact or suggestion which may not have occurred to others.

I venture now to draw attention to some of the ways in which this Royal Society may be applied to considerable public advantage. It might render good service to any Government of the day, by being a Board of reference to discuss and report upon questions of the greatest practical importance—the number of which is continually increasing. Perhaps some good might have resulted if there had been referred to them such subjects as the water supply of Sydney,—the best means for ensuring health in this populous, but badly drained city,—the preservation of its magnificent harbour by preventing it from being silted in, as it now is; destroying some of its natural beauty, and impeding the progress of commerce.

I may observe also that the disease in fruit trees, and Mr. Mort's freezing apparatus, would have been interesting and useful subjects for discussion.

The late Mr. Justice Wise pointed out the importance of ap-

plying the means of the Philosophical Society to the compilation of a history of the aborigines of New South Wales before they became extinct. It is to be hoped that the time will ere long arrive when this society will be in a position to assist, not only in such a work as this, but in the systematic organization of scientific expeditions; and also be able to award medals to inventors, and the authors of valuable original treatises.

That the Philosophical Society of New South Wales was for some time in a languishing condition there can be no doubt. Many seemed to be misled by its apparently exclusive title, and this was one reason for placing ourselves under the Royal Arms. But,

> "What's in a name? That which we call a rose,
> By any other name would smell as sweet."

And so the title "Philosophical Society" might, to many, smell as sweet as the one now adopted; but unhappily the former did not continue to serve us, and so languishing had the society become a few years ago, that I believe one of our members, and a valuable one too, jocosely proposed that we should wind up by selling our debentures, and giving a grand picnic with the proceeds.

However, we have changed our name, and adopted that of similar societies in Great Britain, and the adjacent colonies, and I am happy to say we are exhibiting signs of fresh vitality.

But even the Philosophical Society was for many years eminently useful and instructive, and every one who looks at the list of papers read before it, must be struck with the wide range of subjects embraced, especially those of practical importance; many that might be listened to and understood by any one present, and all showing that there is amongst us no want of zeal, talent, and energy.

An occasion like the present should not be passed over without an expression of hope that in future, ladies will not only grace with their presence the conversaziones of this society, but will sometimes attend the ordinary meetings.

It is no uncommon thing in London, to find a very fair proportion of ladies at the meetings of the Geographical and Geological Societies, as well as in the theatre of the Royal Institution.

Without wishing to pay fulsome compliments it may be asserted that in general, ladies are neither uninterested nor inappreciative

of science—and they certainly are not incapable of understanding it. Fashion indeed may have drawn a line of demarkation between elegant accomplishments, and the less inviting study of science; but, without the sacrifice of any gentleness or refinement, I can discover no reason why that boundary should not be passed, and ladies have the opportunity of studying the laws of Nature, and a selected system of geometrical reasoning. Since the establishment of ladies' colleges, which, in London especially, has met with such successful results, few will be found to assert that the young ladies educated there have made wives less useful and daughters less agreeable in society than those who have not adopted the same course; or that they are less proficient in music, singing, and drawing, because they have studied the logic of Euclid, the rules of decimals, which will enable them to keep the accounts of their houses without difficulty when the decimal coinage becomes law, the general principles of mechanics, and some of the important facts of chemistry and geology. They should know that the phrase "learning astronomy," does not mean merely looking out on a fine night, and being able to point out Venus, Saturn, Jupiter, Mars, and Orion. They should rather learn that astronomy is the most comprehensive of all sciences; that to be interested by it and understand it in all its sublimity, they should acquire some knowledge of the motion of the planets, and the form of their orbits, the laws which regulate their motions, and of the relative magnitude of their masses; they should learn that the fixed stars are, perhaps, incorrectly termed so, and that they may be systems in motion larger than our own; and that the sun itself, together with its attendant planets, has, we believe, a proper motion of its own in space. They should know, also, that the phrase "learning geography and ths use of the globes," does not mean a mere knowledge of places and countries, and taking off a latitude and longitude from a common globe; but that it cannot be studied properly except, to a certain extent, in connection with history and geology.

If any illustrations were needed to show that a knowledge of science in ladies is not inconsistent with ther natural refinement, or incompatible with their usefulness in domestic and social life, I might instance such names as Miss Caroline Herschel, who discovered the Georgium Sidus; Mrs. Mary Somerville, the authoress

of a work on Physical Geography, and the connection of the Physical Sciences; or Mrs. General Sabine, who has made her reputation by her translation of Humboldt's Cosmos. All these ladies, and many others, though possessing scientific acquirements, in an eminent degree, yet were exemplary and unobtrusive in their private life; and though well acquainted with the use of elaborate scientific instruments, were not above handling that more humble instrument—the needle.

There is another point which I allude to with some diffidence, yet with the conviction that the present occasion ought not to be passed over without some allusion to it. In the present day there are opinions entertained, even by men of superior intellect, that revealed religion and science are antagonistic; but so far from being so, there is the greatest harmony between them. And why is it that such views are entertained? It is the difficulty of admitting that the highest human mind is limited, and cannot grasp infinity. What does the immortal Newton say? "I know not what the world may think of my endeavours, but to me it seems that I have been a child wandering on the sea shore, sometimes picking up a prettier pebble or more beautiful shell than my companions, whilst the great ocean of truth lay undiscovered before me." Yet this man was the greatest philosopher that ever lived—

> "Nature and nature's laws lay hid in night,
> God said let Newton be, and all was light."

There are two very forcible ideas suggested in the works of the celebrated Babbage.

In what he calls his ninth Bridgewater treatise, he remarks to this effect—that as it is now universally accepted that the imponderable elements, light, sound, and heat, are transmitted through space by means of undulations acting in an ætherial medium, just as we observe a succession of waves on the surface of water into which a stone is dropped, and which becomes lost to the finite sense only. How then can we say but that every oath or idle word spoken by man may be transmitted through space to the recording angel.

That such a medium does exist there can be no doubt, else how does light reach us from bodies at such an immense distance as the sun and stars. Again, Encke's comet plainly shows by the

remarkable and perceptible diminution of its orbit, that it is moving in a resisting medium, and will eventually fall into the sun. And following up this suggestion of Babbage about the propagation of every uttered whisper, I may mention a remarkable supposition of some modern philosophers, that the image of an object formed upon the retina becomes permanently impressed there, so much so that it is said a murderer has been detected in consequence of his image being found depicted on the retina of the murdered man's eye.

One more point in the writings of this philosopher, I will refer to with your patience. It has been remarked by atheistical writers, that "Miracles cannot be true, because they are contrary to experience." But Babbage, who is not only a profound mathematician, but a very practical and liberal philosopher, reminds us of a remarkable fact, well known to the student of the abstract study of pure mathematics.

There are a multiplicity of curves, all of which follow some general law dependent upon the principles of geometry or mechanics. To take some simple instances:—The circle has for its law that every point in it is equally distant from the centre. This is practically evident to anyone who has a pair of compasses.

Then there is the Ellipse. One of its properties being, that if a continuous string be attached to two fixed points, and a moveable peg made to trace a curve, the string all the time being kept stretched, the two lengths added together will be always the same. It is a curve which most planetary bodies describe. The method is known to most practical gardeners.

Then there is the Parabola, or the path described by a bullet projected from a rifle.

And so we might continue. But as we proceed, we arrive at a class of curves as certain in their nature as any that I have referred to, and following as much a general law. But in some of them an apparent paradox occurs. There are certain points called "singular points," which are essentially points in the curve, and yet do not lie in it. They are derived from the same general law, and yet form *apparent* exceptions. And so Babbage argues, and with good reason, that miracles may be beyond our comprehension; and although they may be apparently contrary to the general laws of Nature, yet they may be but singular ex-

ceptions, and form as much parts of the general law, as other admitted instances,

No one, I think, who watches the signs of the times, can help perceiving that the progress of science is commensurate with the progress of civilisation. Orators may prate about millions spent in the maintenance of standing armies, the construction of ironclads, and the manufacture of Armstrong guns and needle rifles; but all there are the safe-guards of peace, and would seem to be precursors of the time when "swords shall be turned into pruning hooks, and men shall learn war no more." All this, and more, is due to science.

When, then, we consider the energy of thought, talent, and labour, which is being displayed now, whether it be in the construction of a watch, the construction of railways over Mount Cenis, or the Blue Mountains of this country, or the geographical discoveries in Africa, and its probable consequent civilisation, or the electric wire which transmits a message from London to New York with, almost, the rapidity of thought, may we not, without levity or presumption, look upon them as the human means by which "the earth will be filled with the knowledge of the Lord as the waters cover the sea?"

ART. 1.—*On the Value of Earth Temperatures, by G. R. Smalley, Esq., B.A., F.R.A.S., Vice-President.*

[Read July 1st, 1868.]

THE remarks that I have to make this evening will be brief and general; and it is rather with a view of inviting consideration and future discussion on a most important subject, than of entering upon it with that careful preparation that it deserves, that I offer any remarks to this Society upon the instruments exhibited here this evening.

The main objects of such experiments as I am alluding to, is to determine the law of temperature at different depths below the surface of the earth.

There are great difficulties attending such experiments, viz :—

1st.—There is the difficulty of obtaining Thermometers of sufficient lenghts.

2nd.—There is the difficulty of obtaining a site corresponding to the mean sea level, which clearly ought to be the starting point from which such observations should be made.

3rd.—There is the difficulty of providing for a regular systematic set of observations, which, as a general rule, can only be carried out at a public Observatory, to answer the previous conditions.

The first enquiry from such experiments would naturally be the important question as to the existence of a great internal fire. This theory would be borne out, not only by the laws of mechanics, but by the observations which have so repeatedly been made in Artesian wells and in Coal Mines.

The general results arrived at from experiments, appear to prove that the temperature of the earth increases at the rate of 1° Fahrenheit for every depth of 55 or 60 feet.

It is remarkable that Humboldt, whilst he admits this fact in a variety of instances, yet seems inclined in his "Cosmos" to doubt whether the temperature of the earth does *increase* or *decrease* as we descend beneath the surface. But we must remember that when Humboldt wrote his "Cosmos" no systematic observations of Earth Temperature had been carried on. And even at the present time I have the greatest difficulty in obtaining such observations.

So far as I am aware, the only observations of this class have been made at Greenwich, Edinburgh, Kew, Paris, and Melbourne,

Paris would, perhaps, afford the most satisfactory results, for one reason especially, as being on a comparatively low level. But I am sorry to say that I have no records of any observations of earth temperature made there. The same with Kew—the same with Melbourne. Yet, no doubt, very valuable results might be obtained from all these places.

No doubt there is very great difficulty in carrying on these experiments, and I would hardly have ventured to bring this question forward to-night, if I had not been requested to do so.

The Thermometers exhibited in the hall this evening are of the following lengths, viz :—

No. 1.	20 feet
„ 2.	11 „
„ 3.	6 „
„ 4.	3 „
„ 5.	——

These Thermometers were supplied by Mr. Grimaldi, of Melbourne, and I am bound to say that he has discharged his duty in the most efficient manner.

The present question is one of the greatest importance—it alike affects the Astronomer, the Geologist, and the Agriculturist.

I should have gone more fully into this enquiry, had it not been that I understood my friend and colleague, the Curator of the Museum, intended to read a valuable paper, and I therefore determined to defer any detailed remarks I might have to offer about Earth Temperature until a future occasion. Indeed, my especial object in exhibiting these Earth Thermometers, is to give the members of the Royal Society of New South Wales, an opportunity of seeing them as they are, before they are buried in the earth.

I hastened to get these Earth Thermometers in action as soon as possible, especially in consequence of a conversation that took place, when I was examined before a select committee of the Assembly, about the disease in Fruit Trees, and its connection with Meteorology. I was then asked what would be the law of temperature at different depths below the earth's surface; and whether it would not be desirable to try experiments for the purpose?

Although I had already written to England about these Earth Thermometers, yet, I was so impressed with the importance of immediate action, and also fearful about the risk of transit to a Thermometer 20 feet in length, that I adopted—as I conceived—the safer and more expeditious course of getting them from our Sister Colony—Melbourne.

But although I am certain that most valuable results will be obtained from Earth Thermometers, at the same time, it is equally certain that they should be made on a most extensive scale to be of practical and scientific utility. I believe the great desideratum should be to obtain localities as near as possible to the level of the sea. There is my own Observatory, which is 155 feet above the level of the sea, yet my deepest Thermometer will be 20 feet only, and the same remarks must apply to Greenwich and Edinburgh.

I have made these remarks especially with a view to guard against any misconception as to the hypothesis that the law of temperature will be the same in any locality whatever. Such a condition is hardly attainable, and could hardly be expected.

It is well to give an illustration of the subject of my discourse this evening, and I have selected the observations made at Edinburgh, for the following reasons, viz :—

1st.—They extend over 23 years, (from 1837 to 1859, inclusive,)

2nd.—They give the greatest range of depth, viz., from 3 feet to 32 feet.

3rd—The Thermometers were actually constructed, and the observations made (personally) by no less a philosopher than Professor Forbes.

I place the results of this investigation on the table, without reading the details. I will merely draw your attention to the fact, that taking the average of 23 years, the readings of the Thermometer are as follows :—

3·2	feet below the surface	46° 4
6·4	" " "	46° 7
12·8	" " "	47° 0
25·6	" " "	47° 2

I look upon these results as most valuable, for the reason I have given ; and it will be seen that the increase of temperature as the depth increases, is most distinct, though a strict mathematical law may not be apparent, which, indeed, in the present state of science, it would be unreasonable to expect.

In conclusion I shall merely observe that the long series of Edinburgh observations appear to show that the highest temperature of the earth's crust occurs about the Autumnal Equinox—the lowest, about the Vernal.

Art. II.—*The Improvements effected in Modern Museums in Europe and Australia, by Gerard Krefft, Esq., F.L.S., C.M.Z.S., &c., &c., Curator and Secretary of the Australian Museum.*

(Read before the Society, 5th August, 1868.)

The interest which all classes take in Natural History, has gradually changed the old fashioned curiosity shops of fifty years ago, into useful Museums—where rational amusement, combined with instruction, is offered to the mass of the people, and where students have every opportunity to examine and study the specimens, of which the Museum consists. With the British Museum for a model—we had, at first, adopted almost everything that is good and bad in that great Institution, till experience showed plainly that there was much room for improvement, and, this it appears has also been felt by Dr. J. E. Gray. In a pamphlet sent to me by last mail, the Principal Keeper has suggested to the British Museum Trustees, certain alterations which I have advocated for years, and which, as far as it was possible, have long been adopted in our own Museum.

The arrangement of the specimens has been already carried out on the same plan, now proposed by Dr. Gray, and given satisfaction to the general visitors, as well as to the student.

It must be borne in mind, however, that the due disposition of the numerous specimens for advantageous exhibition is at present *in statu quo*, owing to the laying of encaustic tiles in the centre hall of the new wing, and consequently the contents, amply sufficient for two rooms, are now crowded into one. One of the great improvements in modern Museums, has thus already been tested, namely, that all cabinets should be moveable, and fixed on rollers. If the old plan had been adopted of building the cabinets on the floor, the public would have been deprived of inspecting the best part of our collection, for at least four months to come.

I will now, with your permission, quote Dr. Gray, whose experience in the largest and most important Museum in the world, extends over a life time, and whose opinion should be well considered by those, who are about establishing private or public Museums in these colonies:—

"It is easy to devise the plan of a Museum, which shall be the most interesting and instructive to general visitors, and one from which, however short their stay, or however casual their inspection, they can hardly fail to carry away some amount of valuable information.

"The larger animals, being of course more generally interesting, and easily seen and recognized, should be exhibited in the preserved state, and in situations where they can be completely isolated. This is necessary also, on account of their size, which would not admit of their being grouped in the manner, which I propose with reference to the smaller specimens.

"The older Museums were for the most part made up of the square glass-fronted boxes, each containing one, or sometimes a pair of specimens. This method had some advantages, but many inconveniences—among others, that of occupying too large an amount of room. But, I cannot help thinking, that when this was given up for the French plan of attaching each specimen to a separate stand, and marshalling them like soldiers on the shelves of a large open case, the improvement was not so great as many suppose; and this has become more and more evident since the researches of travellers and collectors, have so largely increased the number of known species, and of species frequently separated by characters so minute, as not to be detected without careful and close examination.

"Having come to the conclusion that a Museum, for the use of the general public, should consist chiefly of the best-known, the most marked, and the most interesting animals, arranged in such a way, as to convey the greatest amount of instruction in the shortest and most direct manner, and so exhibited as to be seen without confusion; I am very much disposed to recur to something like the old plan of arranging each species, or series of

species in a special case (to be placed either on shelves or tables, or in wall cases, as may be found most appropriate, or as the special purpose for which each case is prepared and exhibited may seem to require).

"But instead of each case, as of old, containing only a single specimen, it should embrace a series of specimens, selected and arranged so as to present a special object for study; and thus any visitor looking at a single case only, and taking the trouble to understand it, would carry away a distinct portion of knowledge, such as, in the present state of our arrangements, could only be obtained by the examination and comparison of specimens distributed through distant parts of the collection.

"Every case should be distinctly labelled with an account of the purpose for which it is prepared and exhibited; and each specimen contained in it should also bear a label, indicating why it is there placed.

"I may be asked, Why should each series of specimens be contained in a separate case? but I think it must be obvious that a series of objects, exhibited for a definite purpose, should be brought into close proximity, and contained in a well-defined space, and this will best be done, by keeping them in a single and separate case There is also the additional advantage, that whenever, in the progress of discovery, it becomes desirable that the facts for the illustration of which the case was prepared, should be exhibited in a different manner—this can easily be done by rearranging the individual case, without interfering with the general arrangement of the collection. I believe that the more clearly the object is defined, and the illustrations kept together, the greater will be the amount of information derived from it by the visitor, and the interest he will feel in examining it.

"Such cases may be advantageously prepared to show—

The classes of the animal kingdom.

The orders of each class.

The families of each order.

The genera of each family.

"The sections of each genus, by means of one or more typical or characteristic examples of each class, order, or section.

"A selection of a specimen of each of the more important or striking species of each genus or section.

"The changes of state, sexes, habits, and manners of a well-known, or an otherwise interesting species.

"The economic uses to which they are applied, and such other particulars as the judgement and talent of the curator would select as best adapted for popular instruction, and of which these are only intended as partial indications.

"No one, I think, who has ever had charge of a Museum, or who has noted the behaviour of the visitors while passing through

it, can doubt for a moment that such cases would be infinitely more attractive to the public at large, than the crowded shelves of our present Museums in which they speedily become bewildered by the multiplicity, the apparent sameness, and at the same time the infinite variety of the objects presented to their view, and, in regard to which, the labels on the tops of the cases afford them little assistance, while those on the specimens themselves are almost unintelligible.

"When such visitors really take any interest in the exhibition, it will generally be found that they concentrate their attention on individual objects, while others affect to do the same, in order to conceal their total want of interest, of which they somehow feel ashamed, although it originates in no fault of their own.

"I think the time is approaching, when a great change will be made in the arrangement of Museums of Natural History, and have therefore thrown out these observations as suggestions, by which it appears to me, that their usefulness may be greatly extended.

"In England, as we are well aware, all changes are well considered and slowly adopted. Some forty years ago, the plan of placing every specimen on a separate stand, and arrangiug them rank and file in large glass wall cases, was considered a step in advance, and it was doubtless an improvement on the pre-existing plan, especially at a time when our collections were limited to a small number of species, which were scarcely more than types of our modern families or genera.

"The idea had arisen that the English collections were smaller than those on the Continent, and the public called for every specimen to be exhibited. But the result has been, that in consequence of the enormous development of our collections, the attention of the great mass of visitors is distracted by the multitude of specimens, while the minute characters by which naturalists distinguish genera and species, are inappreciable to their eyes."

It will be seen from this that our great Museum authority has no longer any faith in ths old fashioned arrangements, and if wall cases are found inconvenient in a cold climate like England, how much more dangerous must they be in Australia? The cabinets in the Melbourne Museum are arranged end on between the windows—the narrow part touching the wall, and leaving three sides free, so that back and front of the specimens can be inspected, and dangerous insects destroyed whenever they make their appearance. Where wall cases in particular those without glass tops are in use, the destruction from the attack of insects is very large, and the labour and expense to keep a collection well preserved, will amount to a considerable sum during the year.

The most useful cases, and those best adapted for our climate which I have seen, consisted of iron and glass only; they could be taken to pieces and removed without much labour—an advantage well worth consideration, where, as often happens in young communities, the embryo Museum is only temporarily located in some vacant room, or where it is desirable to shift the cases to an upper story.

I have already experienced the advantage of making the cabinets portable, and all the table cases now in use in the Australian Museum, can be taken to pieces.

Dr. Gray recommends that no specimens should be placed higher than about five feet from the bottom of the case, and this plan I have always endeavoured to carry out as much as possible. It is distressing to see visitors on tiptoe, trying to read the names of specimens raised above this level, and the objects thus become quite useless, except to the Curator, who requires a ladder when he wishes to inspect them.

Dr. Gray recommends the exhibition of specimens as follows:—

"Mammalia and their skeletons, being of a large size, require to have good-sized rooms.

"The birds and other animals, being small, are better seen in moderate-sized rooms, as large rooms dwarf the size of their specimens.

"The rooms and the cases in them need not be alike, as that tires the eyes of the visitors.

"Too much and too brilliant ornamentation of the rooms and cases kill the specimens; but, at the same time, they need not be like the rooms of a "dock warehouse."

"The rooms should be lighted so that the specimens shown, can be seen in dark weather; but the lights should be easily under control, by blinds or other means, as excess of light, especially of direct sunlight, even through blinds, is a very great evil in a Museum, and it often destroys the colour, texture and otherwise injures the specimens.

"Galleries are very well as make-shifts where ground is scarce or not to be had. They are always inconvenient if they are used for a part of the collection open to the public. Their use also prevents the museum from having sufficient floor space for table cases, which show many kinds of specimens, much more conveniently than wall cases; indeed there are some specimens that cannot be shown, except in table cases.

"If the skeletons of whales are exhibited, they are much better seen when placed in the middle of a room, or raised only slightly above the floor, so that they can be seen by persons walking, or at most, not raised higher than the skeleton of the Greenland whale now shown at the College of Surgeons. When suspended

from the roof, they can only be very imperfectly seen or understood."

The plan to mount whale skeletons as Dr. Gray proposes to the Museum Trustees, is not to be recommended where visitors are so indiscriminately admitted as they are in Museums in Australia. I think specimens of this kind would not suffer much injury from being exposed, but it is always better to guard against accidents.

A whale skeleton with its lowest part, should be sufficiently high from the ground to enable a person to walk beneath it, and, if there is no gallery, to view it from above, it would be well to erect a raised platform for this purpose.

Great creatures, such as whales, look very formidable as a whole, but taken to pieces they are easily managed, and I am prepared at any time, having the iron work ready, to set up the largest whale skeleton in two days. Our sperm whale is 35 feet long, the head weighs nearly a ton, and it has never taken 24 hours to remove it (irons and all) from one place to another.

The first time it was ever under shelter, was when put up in an over crowded Museum, above a number of cabinets, and supported within four iron arches, it was then six feet off the floor, and could be viewed to great advantage from the gallery. Having been removed into the new Museum, which has no gallery, it was found that it could not be seen so well; but as soon as the pavement in the centre hall is ready, the whale will probably be located there, because an excellent sight of the monster may be had from the staircase.

The skeleton being on a moveable platform, can be shifted wherever it is required—another illustration of the advantage to have all specimens on rollers.

Separate rooms for every department are not necessary. I think this may be desirable in England, or on the Continent, where Museums are open only two or three days during the week, and where the professor and his students require such an arrangement, but as our institutions are principally for the amusement and instruction of the general public, we do not want separate rooms. Visitors who come for the purpose of study, are always admitted from 9 till 12, before the doors are open for the day.

I now come to a very important subject, and that is, the desirability of having certain specimens kept in skins for the use of the student. Anybody who has inspected the first floor of the new wing, will remember the fine series of Australian and Indian birds kept in skins, and exhibited a pair of each in shallow glass cases. Their names, the locality where, and the date when they were shot, are neatly written by Mr. George Masters, underneath each species, who brought this fine collection together, and arranged

the series in such a manner, that every school-boy can easily find the bird he wishes to know.

In the same way the bones, and in particular the sterna of birds, so important in their classification, have been arranged; the fossil remains are also exhibited in this way, close to the mounted skeletons of several extinct birds.

In the Mammalian department there is also a series of mounted skeletons, besides a number of boards, each with a skeleton put down flat—a new way of arranging bones, which has since been adopted by many of my colleagues in England and on the continent of Europe.

A very important arrangement is, to have the teeth of animals mounted on glass slides, each species on a separate piece, besides preserving a skull in a stopper bottle. This plan answers excellently for comparison when classifying fossil remains.

I may also draw attention to the advantage glass has over wood or millboard, for mounting in particular delicate specimens; all the shells, the greater part of the smaller fossils, and other objects are thus exhibited in the collection. The paper upon which they rest never becomes dirty, and any color can be chosen, and removed if necessary without much trouble.

Everybody who has mounted specimens, know show troublesome and impracticable wood or cardboard is, and how easily objects are broken when removing them. Glass always keeps straight, wood and card-board warp. If a specimen is to be changed, the glass is only held for a second over a spirit lamp, and the shellac or gum mastic gives way at once.

I must now again quote Dr. Gray, to prove that almost every single proposition which he makes to the British Museum Trustees has been partially carried out in Australia years ago, and this assertion will be found further strengthened as soon as the necessary table cases are made, which will enable the Trustees to exhibit their collection to the best advantage, both for the student and for the general visitor.

Dr. Gray remarks: "What the largest class of visitors, the general public, want, is a collection of the most interesting objects, so arranged as to afford the greatest possible amount of information in a moderate space, and to be obtained, as it were, at a glance. On the other hand, the scientific student requires to have under his hands the most complete collection of specimens that can be brought together, and in such a condition as to admit of the most minute examination of their differences, whether of age, or sex, or state, or of whatever kind that can throw light upon all the innumerable questions that are continually arising in the progress of thought and opinion.

" Every scientific student requires the cases to be opened, to allow him to examine and handle the specimens, and in the stuffed

state this cannot be often done without injury; and an artist always requires them to be taken out of the case for his purpose.

"In the futile attempt to combine these two purposes in one consecutive arrangement, the modern museum entirely fails in both particulars. It is only to be compared to a large store or a city warehouse, in which every specimen that can be collected is arranged in its proper case and on its proper shelf, so that it may be found when wanted; but the uninformed mind derives little instruction from the contemplation of its stores, while the student of nature requires a far more careful examination of them than is possible under such a system of arrangement, to derive any advantage; the visitor needs to be as well informed with relation to the system on which it is based as the curator himself; and consequently the general visitor perceives little else than a chaos of specimens, of which the bulk of those placed in close proximity are so nearly alike that he can scarcely perceive any difference between them, even supposing them to be placed on a level with the eye, while the greater number of those which are above or below this level are utterly unintelligible.

"To such a visitor, the numerous species of rats, or squirrels, or sparrows, or larks that crowd the shelves, from all parts of the world, are but a rat, a squirrel, a sparrow, or a lark; and this is still more especially the case with animals of a less marked and less known type of character. Experience has long since convinced me that such a collection so arranged is a great mistake; the eye, both of the general visitor and the student, becomes confused by the number of the specimens, however systematically they may be brought together.

"The very extent of the collection renders it difficult even for the student, and much more so for the less scientific visitor, to discover any particular specimen of which he is in quest; and the larger the collection, the greater this difficulty becomes. Add to this the fact that all specimens, but more especially the more beautiful and the more delicate, are speedily deteriorated, and in some cases destroyed for all useful purposes, by exposure to light, and that both the bones and skins of animals are found to be much more susceptible of measurement and comparison in an unstuffed or unmounted state, and it will be at once apparent why almost all scientific Zoologists have adopted for their own collections the simpler and more advantageous plan of keeping their specimens in boxes or drawers, devoted each to a family, a genus, or a section of a genus, as each individual case may require.

"Thus preserved and thus arranged, the most perfect and the most useful collection that the student could desire would occupy comparatively a small space, and by no means require *large and lofty halls for its reception.*"

The British Museum plan of exhibiting stuffed fishes and rep-

tiles only, and keeping the spirit specimens in the cellar, has not been adopted by our Trustees, because the larger number of specimens being Australian, can be re-placed; duplicates are always kept in a dark room for this purpose, and as the Museum is well supplied by Professional and Amateur fishermen, we can always exhibit most of our genera and species.

The large fossil reptiles and fishes, I find, are best displayed on slanting platforms; in this manner the large "Plesiosaurus Cromptonii," above thirty feet in legth, is shewn to great advantage, and at the least possible expenditure of space or money. This large fossil is screwed with bolts on to the boards, and the margin is then plastered with cement, gradually coming level with the board, so that it has the appearance of a large solid slab. Smaller objects, as skeletons of Crocodiles, Gavials, Fossil Fishes, &c., are fastened on by wire.

Now, in the Dublin Museum, the original P. Cramptonii is arranged on a gigantic horizontal platform or table, taking up an immense amount of room, without showing much of the animal.

Let me now say a word about the invertebrate animals, in particular the class Insecta, and let me draw attention to the necessity of having the very best and most faithfully made cabinets for them. Few persons have the slightest idea how expensive it is to keep even a moderate collection of insects in good order, in particular when the cases are badly constructed.

The fearful dust, and the ravages of the larvæ of a small beetle (Anthrina) make havoc in the best kept collection, if it is not constantly looked after. For insect cabinets I would propose such as do not open at the top, which would at least prevent the dust from entering. I cannot now go into detail, as this paper has extended (already) to a much greater length than I expected.

I observe that Dr. Gray proposes to exhibit simultaneously, and visible at a glance, the egg, the larva, the plant on which it feeds, the pupa, and the perfect insect, together with its varieties, and the parasites by which the caterpillar is infested—a most excellent plan, which can however be carried out only to a limited extent. As far as it is possible it will be done here also, the commencement being made with insects such as are found to be destructive to our plantations, or useful to our manufactories.

Dr. Gray does not touch upon the mineral collection, which should be well displayed in a country so rich in metal as ours. Thousands of the most interesting specimens, all arranged, labelled, and catalogued, fill almost every available drawer in the Museum, visitors, daily, ask to see these treasures; miners are disappointed that their interests are so little considered; but very few know that the display cannot take place because there are no cabinets to protect these valuable collections. It is said that these things are better managed in Melbourne, and I can only

state, that I think we are doing wonders, with an endowment of £1,000, and a supplement of £200 a year. The Museum is now four times as large as it was five years ago, and still the Trustees manage to keep the place in order with this small sum. There is of course no money to buy Gorillas—for which the Victorians spent more than we can spare—so we must content ourselves to exhibit drawings of the great Ape which is only represented in the baby state.

This brings me to another most important subject, the exhibition of highly interesting, or rare specimens, engraved or photographed. A photographic establishment is one of the most essential parts of a modern museum, and what can be done in a small way may be gleaned from the specimens now exhibited. These photographs could be transferred to stone with little expense—there are able artists in Sydney who can do this as well as the best in England—and by such a means New South Wales might pay some debts of long standing to those liberal minded institutions who for years past have sent their valuable publications without ever receiving the slightest return. Look at the publications of other museums; why cannot a few hundred pounds a year be spared to make our wonderful productions known to the world? Why have we to send contributions to other countries for publication? Would it not be better to expend a small sum in this way here? It is money well laid out and will greatly assist in educating the people. It is only the first advance of four or five hundred pounds which is required, the sale of copies would soon cover the expenses. Since writing this, I have had some conversation with Mr. Victor Prout, our well known artist, who, in the most liberal manner, has photographed a few specimens at the Museum, and with his fine instrument enlarged some of them to the size of life. I ask the members present, can there be anything which would give a better idea of what animals are? The Bearded Lizard, in particular, is a splendid example of the photographic art. Taken from life, Mr. Prout had great difficulty in producing a good picture, but succeeded at last, and I think it would be well to have such works lithographed.

The Diamond snake, by Mr. Barnes, enlarged by Mr. Victor Prout, is also from a living subject, and could not well be surpassed.

In concluding this paper, I cannot but mention the great assistance which our Museum always derived from the schoolboys of this city, many of whom are now among the pioneers at the Gulf, or growing cotton at Fiji. They always remember the old place, and often send the most valuable contributions. I deeply regret the loss of one of my young friends, who was indefatigable in his exertions to serve science whenever he could, and to whom

the Museum is indebted for a valuable series of eggs, birds, fishes, and mammals. John Edward Dunn was well known to many of our fellow colonists, and he lost his life in the pursuit of his favourite study, trying to serve the Museum where so many of his leisure hours were spent.

ART. III.—*On the Hospital Requirements of Sydney, by Alfred Roberts, Esq.*

[Read, 14th August, 1868.]

THE subject of the following paper, although of a quasi professional character, must always be of considerable importance, and at the present time is one in which the public feel an especial interest. I have, therefore, thought that a few remarks on Hospitals, however unworthy in themselves, might be acceptable to the Royal Society, and would, by the discussion which they evoke, assist in giving a direction and form to the reflections of the community. I shall invite you to consider—

1st. The class for whose benefit it is necessary in this country to provide hospital and infirmary accommodation.

2nd. The arrangement of this class into such sub-divisions as will allow of the required relief being given in the most efficient and economical form.

3rd. The character of the structures which appear most suited to each division, and the nature of the site upon which they should be placed.

4th. The condition and fitness of existing buildings for the purposes in view.

1st. I would define the class of citizens for whom it is necessary to provide gratuitous hospital or infirmary accommodation to be those chiefly of the hand-working class, whose circumstances in life deprive them for the time being of the ability to pay the expenses incident to an illness, or serious corporal infirmity. The individual may be a blind beggar, or a clerk, the illness a temporary indisposition, or a railway accident; in either case it is the custom of Englishmen to provide from the purse of charity the means necessary to restore, if possible, the sick and maimed to health and society.

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2nd. We have to classify those to whom we have agreed to afford assistance, for the purpose of efficiency and economy.

This will most effectually be carried out by separating them into three classes.

1st. Those who, meeting with accidents, or being afflicted with acute disease, cannot be safely removed to a distance, or who, if removed, could not receive that amouut of medical attendance and careful nursing which the urgency of their disease demands; with these I would place such sub-acute cases as require the highest class of medical treatment, diet, &c.

2nd. Those who, having battled through acute disease, remain weak, requiring continued rest, with change of air and scene, and good diet, to restore them to such vigour of body and mind as will enable them to resume the laborious duties of their station. We may also class with these all chronic cases of disease requiring for their relief a passive treatment of considerable duration.

In the third division we find the infirm and incurable separated perhaps, in many instances, but little from the pauper, but still as a class possessing a distinct claim for the consideration of those who undertake to deal especially with the illness and infirmity of mankind.

We have next to consider the character of the buildings required—and first we will deal with those for the reception of cases of accident and acute disease. For these it must be allowed that a central hospital is essential, and experience has proved it to be necessary; the only point upon which issue has been raised being as to the amount of accommodation, in proportion to the extent and character of the population.

The Central Hospital should afford such accommodation only as will suffice for the reception of all severe accidents, and acute cases of disease. I consider that no such establishment should be larger than will be necessary to meet this requirement, and that most cases of protracted disease should be drafted off to a convalescent hospital placed at a distance from the metropolis.

The proper proportion of hospital accommodation to population is calculated in England to be about 300 beds to 120,000 persons, but this must be regarded only as a proximate estimate; local circumstances will have to be taken into consideration, as well as the nature of the hospitals to be provided.

As it will be impossible to calculate the accommodation which will be required in a central hospital, separately from that which has to be provided for in the hospital for the reception of convalescing and chronic cases, I will at once endeavour to attain a proximate idea of each—the infirmary requirements being left for the consideration of the Government.

Considering the imperfectly developed condition of the country districts, and the large number of patients which therefore come

from various parts of this and other colonies for hospital treatment in Sydney, and the nature of our metropolitan and suburban population, I am disposed to afford a much higher proportionate amount of hospital accommodation than that mentioned above. The nearest estimate which I can obtain of the population of the city and suburbs is 121,000, and I venture to recommend 600 hospital beds as necessary to meet our present requirements. Of this number, 350 should be provided in Sydney, and 250 in the country branch establishment. Of the latter, 150 would probably be required in the chronic case department, and 100 in the convalescent wards. The number here calculated for Sydney is supposed to be in excess of the actual demand for acute cases and accidents, in order that a sufficient number of clinical and special cases may be accommodated, and that the beds may always be sufficiently numerous to afford full and varied experience to students of medicine.

In the following remarks upon the construction of Central General Hospitals I shall endeavour to embody all that it appears desirable to mention in so short a paper as this must necessarily be, leaving only special features of difference to be alluded to, when other and less complete forms of hospitals come under consideration.

Hospitals not built upon the isolated or pavilion principle are prone to engender hospital disease among the patients, while very large pavilion hospitals extend over an inconveniently large area, involving a great expenditure of labour and time in furnishing the requisite supplies of food, &c., increasing also the difficulty of supervision and management.

Simplicity of plan and general management being accepted as essential, an hospital should not exceed that size which is capable of possessing a central executive department within easy reach of all its wards.

It appears to me that under no circumstances should a general hospital be constructed to contain more than from 400 to 500 beds, the former being the more desirable, while for all the purposes of clinical instruction a well-ordered hospital of the size mentioned will fulfil every object, and in many respects will be preferable to a more extended arena for study.

The construction of a modern hospital should therefore be upon the isolated or pavilion principle, more or less modified to meet the exigencies of ground, situation, size, &c.

In a large hospital a separate detached block is required for the administrative accommodation, which it will be convenient to place in a central position, and at right angles to the pavilions.

In small hospitals the administrative department may occupy the central portion of one line of building, having wings containing the wards extending on either side.

In either case, all the wards should be placed in the pavilions or wings, and the whole of the administrative accommodation must be provided in the portion set apart for it.

It is not necessary that the pavilions be placed parallel, or in any other fixed relative position to each other, but it is important that they shuold be detached, having ample space between them, to allow the sun and air free access to the walls and intervening ground.

The aspect of the main walls should be carefully selected in reference to the prevailing winds, and the rays of the sun. The summit of a hill ought to be preferred. Corridors or covered ways must be provided, communicating between the ground floor of the administrative department and that of all the buildings.

The height of the pavilion should not exceed three floors, and Miss Nightingale gives the preference to two. The disadvantage of a third floor is considered by her to consist of the additional labour and intelligence required to carry out the administration, nursing, &c. Without depreciating the advantages of the two-floor system, I am of opinion that a third is quite compatible with health, perfect ventilation, and sufficient surveillance, to insure which it is only necessary to provide those structural arrangements and appliances which no hospital should be built without, while the addition of deep verandahs to each tier of wards (which should always be made in this climate) will quite remove any possibility that the atmosphere of an upper ward could be contaminated by that below it.

It appears to me, therefore, that should special reasons exist for designing pavilions with a third floor, and the ground is favourable for the purpose, there is no valid objection to the course, while the saving in cost of erection at per bed will be considerable.

The new St. Thomas Hospital has three tiers of wards in some of the pavilions, and four in others.

The size of the wards should be that which is best adapted to perfect ventilation, efficient nursing supervision, and which ensures a proper classification of patients. In a hospital of 300 beds and upwards, wards containing from twenty to thirty beds are found to be most suited for general use. But each ward of more than thirty beds, or each two wards of twenty beds, should possess a small adjoining ward for two beds to receive cases which require quiet and special observation. The best position for it is near to the sisters' room.

Wards of a small size are generally objectionable, because unfavourable to discipline, inasmuch as a small number of patients in a ward, without the presence of a head nurse, more readily associate together for any breach of discipline than a large number. One sister is capable of superintending fifty patients if

placed in one ward, or in two wards if her sitting-room is placed between and communicates with them; but she could not so efficiently supervise twenty patients if placed in four or five separate wards. The best width for a ward is from 26 to 28 feet, and the height 15 feet. A row of beds should be placed along each side of the ward, the heads being to the walls. This width is necessary to allow of sufficient room between the feet of the bedsteads for the necessary tables, with benches on either side, easy passage way, &c., &c.

Height beyond fifteen feet is undesirable, it being more important to have the cubic space immediately around the patient.

The walls and ceiling should be of Keene's cement, worked plain.

The floor should consist of the best well-seasoned hard-wood, closely laid, tongued, and wrought to a smooth surface. It should be laid on iron joists, and concrete, with a smooth cement surface on the top, partly with a view of making them fire-proof, partly to prevent sound travelling through, and partly to ensure that no impure air shall pass from the lower to the upper floor. The space between the cement and floor should be freely ventilated.

The necessity for providing a day room for convalescents does not exist in the form of hospital we have at present under consideration, because such patients will not be retained within its walls.

Every two wards having from thirty to sixty beds, or nest of small wards, not carrying in the aggregate more than from fifteen to twenty beds, require a sister's room, in which she may remain when not engaged in her wards. Here she arranges her needlework, keeps her ward stores, linen, rags, special invalid comforts, &c.

Adjoining to the sister's room should be a scullery, fitted with a glazed fire-clay sink, a gas-stove, cupboards, and shelves. In this apartment special invalid comforts should be prepared, poultices made, &c., the ward table crockery washed and kept, &c.

At the opposite or terminal end of each ward should be two small square apartments,—one on either side of the centre window. One of these should contain a bath, detached from the walls, and constructed of Stourbridge fire-clay, glazed inside; also a sink, at which a portable bath can be easily filled and emptied; an urinal, and a range of three white turnover basins upon a marble or slate slab, to which hot and cold water should be laid on.

The other room should contain the W. C., and a sink for ward slops; these should be separated from the ward by a ventilated lobby, with the ventilating windows placed at right angles to each other, and shafts for the escape of foul air—every precaution must also be taken, by a careful use of traps and ventilating pipes, to prevent the drain smell from entering the building. All the waste

pipes should pass directly out of the building, and no drain be allowed beneath any part of it.

All the mechanism of the water-closets, urinals, sinks, lavatories, &c., should be of the most efficient and simple construction, and as little woodwork as possible exposed in fitting it.

All water-closets and lavatories should be strongly lighted day and night, to prevent the possibility of any want of cleanliness.

Linen shoots of glazed earthenware should be provided to every pavilion, with an opening in each ward's scullery, and having at the bottom a small well-lighted and well-ventilated closet.

The ward ashes and dust should be discharged into a dust-shoot of cast iron, opening at the bottom into an iron box.

Each of these should be furnished, with a balanced trap top, and be ventilated by a tube extending above the roof.

Every physician and surgeon is aware of the beneficial influence which a cheerful chamber exercises over a patient; and if such is the case in private practice, where the sufferer is surrounded by the comforting society of friends, and the pleasant associations of home, how much more will the aspect of a large ward affect the sufferer who is compelled to lie among twenty or thirty others?

Every attempt should, therefore, be made to render the ward of a hospital cheerful, and to break its monotony without in any degree effecting its tranquility or healthfulness.

It has previously been recommended that the ceilings and walls should be worked plainly in Keene's cement, avoiding all irregularities in the shape of cornices, &c. In addition to this, it is desirable, in bright climates, that they should be tinted in a colour that will slightly subdue the glare of pure white, afford a tranquilising, yet cheerful effect, and at the same time show the earliest sign of soil. All articles of furniture should be simple, strong, free from ornamentation, and capable of easy and free washing. Good white wood and iron should be the materials used in their construction.

The counterpanes are conspicuous features in a ward, and care should, therefore, be taken to render them effective as bedding, and in their influence upon the appearance of the ward. The best material is rather thin, but strong, openly-woven linen, of a distinct pattern in a single colour, possessing a bright clean appearance.

I need not enumerate the articles of ordinary furniture necessary for a ward, but would recommend that each two adjoining wards should be provided with a portable bath, and each ward of moderate size, one or two large reclining chairs of simple construction, for the use of patients when too weak to sit upright; also a wheel chair in which they can be taken into the verandah. One lifting bedstead should be provided for each fifty patients, and a rope should be suspended from the ceiling, over the centre

of each bed, to enable the patients to assist themselves in difficult movements.

A few aquaria and wardian cases of ferns, &c., are perhaps the best ornaments which can be found; but it is a good plan to have nails in fixed places upon the walls, upon which large oil prints, engravings, or illuminated texts may be hung.

A separate and central bathing establishment should be constructed for general use, and fitted with means for administering Turkish, medicated, vapour, and shower baths.

The operating theatre should be central, roomy, and well lighted for day or night use, of horseshoe shape, supplied with hot and cold water, and a lift for patients. Two small wards should be placed adjoining it, for patients after severe operations, and a dressing room for the surgical staff.

A commodious and cheerful chapel, conveniently placed for the use of all denominations, is demanded in the centre of the establishment.

The main staircases should be of stone, or, what is preferable for the use of invalids, an iron framework with wooden slabs.

The kitchen should occupy as nearly as possible a central position, and be placed in a small building with the scullery, engine-room, and coal-bin. The best form of range is that which stands in the centre of the apartment, the sides of the latter being fitted with dressers, shelves, tables, &c. The doorway should be as convenient as possible to the lift, which travels from the basement to the upper floor of each pavilion.

The diets should not be too limited in number or variety, otherwise the extras will be considerable, and lead to extravagant outlay, great inconvenience, and much confusion in the housekeeping department.

A storeroom for the patients' clothes, fitted with an oven, &c., for their purification, must be provided, in which all clothes belonging to patients should be kept during their sojourn in the hospital.

The dispensary should also occupy a central position, and be provided with a well-appointed laboratory, drug store, gas-stove, &c., also with a small lift to the wards.

It should, of course, communicate with the out-patients' department.

Speaking-tubes should be fitted between the sisters' rooms, kitchen, and dispensary.

A clean linen and clothes store is necessary. It should possess windows on three sides, and be furnished with large light racks, divided into small compartments, in which the linen and clothes can be freely sorted, piled, and aired.

It is most undesirable that a laundry should exist in any town hospital, where all the enclosed land that can be obtained should

be ornamentally planted and well kept. The linen should be transmitted daily to a separate establishment a short distance out of town, where, after efficient and careful washing, it can be freely exposed to the wind and sunshine. Much economy is gained by washing with steam power, and several machines exist from which selections may be made.

In this climate, verandahs from ten to twelve feet in width should extend the whole length of both sides of each floor, and every facility should be afforded for getting patients into them, whenever the weather is fine, for the double purpose of benefiting the patients and relieving the wards.

Outside water-closets—or what are better, earth-closets—are to be provided for the patients when taking exercise in the grounds.

The mortuary should be as much as possible out of sight, and removed from the wards. It should consist of three apartments: reception room, examination room, and preparation room.

The first should be fitted in a manner appropriate to the reception of the dead, and the visits of the relatives of the deceased; the second with every convenience for *post mortem* examinations; the last with shelves, &c.

It will be sufficient to enumerate the various other offices required: Superintendent's office, superintendent's private rooms, quarters for resident medical officers, surgical instrument and splint room; quarters for bath, porters, &c.; board room for directors, receiving and out-patients' waiting-room, dispensary officers' consulting room, dispensary officers' operating room. These must be designed with special reference to the duties for which they are required.

The supply of water should be pure and never failing. This is one of the necessities of hospital hygiene, and nothing can compensate for a scarcity or impurity of this vital element.

Cold water should always be supplied at high pressure, and hot-water pipes should extend throughout the establishment, and be provided with taps in the wards, ward sculleries, lavatories, bath rooms, operating theatre, &c.

The daily supply of water should not be less than from forty to fifty gallons per head for all purposes.

Gas should be used in lighting every department, and the ward light should be so arranged as to insure the immediate removal of the products of combustion, and promote ventilation. The best that I have seen is that adopted at the Chorlton Hospital.

A lift for patients should be provided in every ward building, extending from the basement to the upper floor.

Although volumes have been written upon the subject of ven, tilation, and many fortunes expended in experimental schemes· no system has hitherto been discovered which has in any material

degree proved itself equal to the natural ventilation caused by opposite windows judiciously placed and proportioned.

In the old countries of Europe it has been necessary to find some plan for replacing this natural supply during the frequent inclement seasons, by one in which the air entering the wards could be warmed; and the great difficulty experienced in thus obtaining a sufficient supply of pure air to meet the demands of hospital wards, has led to the cry which has latterly been heard far and near for an increasing cubic space; but I venture to express an opinion, that the steed of science has in this instance been allowed to carry his rider somewhat further than it was judicious to go. No doubt, the principle of the cubic space theory is true, especially when applied to wards occupied temporarily, but it is inapplicable beyond a certain point to those constantly tenanted by a definite number of patients.

The difference between space and ventilation hinges on an interesting point of science, which has been so well laid down by Professor Donkin, F.R.S., that I cannot refrain from giving a brief explanation of it. "It is now generally acknowledged that the products of respiration, like other gases, obey rigidly the law of diffusion, and that even a single cubic foot of air exhaled from the lungs almost immediately spreads itself through the atmosphere of a room, and is, in fact, diluted in the surrounding air. Supposing, then, a man occupying a room of definite size, it is evident that unless as much fresh air is admitted into the room during each respiration as that polluted by the lungs during the same period, the atmosphere of the room must continue to be more and more saturated with poisonous products. If the room be a large one the time taken to saturate its atmosphere will be greater than if it is a small one, and if its size be vast, and it is occupied but for a certain period, it will be necessary to introduce per hour a less amount of air than would otherwise be requisite." Under the circumstances, therefore, of intermittent occupation, cubic space is an important element. The large room has not become poisonous at the time its tenant leaves it, and before it is again required for occupation, diffusion has purified its atmosphere for the next inhaibtants. The degree of purity of a room will ultimately depend in no way on the size of the room, but solely on these two things—1st, the rate at which the emanations are produced; 2nd, the rate at which the fresh air is admitted.

It cannot be denied, as a principle, that in wards constantly occupied space alone has little to do with purity of atmosphere. The difficulties and large expenditure which attend every attempt to ventilate hospitals in England, fortunately, do not to the same extent hamper our endeavours in Sydney, and I shall now proceed to explain the system which appears to me calculated to offer the most satisfactory result.

In the attempt to do this I would acknowledge the fair importance of cubic space, and adopt the amount of 1500 feet as that which is at the same time beneficial without being superfluous, and therefore expensive to provide. This quantity is required.

1st. As a necessary adjunct of efficient ventilation.

2nd. To allow of sufficient space between the beds for the prevention of contaminated atmosphere passing from one bed to that next to it.

3rd. To admit room for an intervening window.

4th. To allow the free movement of three or four persons between the beds, with the use of a portable bath, and other necessary ministrations.

5th. To admit the introduction of pure air without producing draughts.

The number of beds to occupy each ward should be defined in the plan, allowing a superficial area of 100 feet to each bed. A window should be placed between each two beds, extending from 2 feet from the floor to within 3 feet of the ceiling, and having a width of not less than 30 inches: over each bed an oblong window should be placed, about $4\frac{1}{2}$ feet long by 3 feet deep, the upper edge of this should reach to within six inches of the ceiling. These should open upon a hinge from the lower edge and inwards.

The centre upright window in each large ward upon each side should be carried down to the floor, and the lower two-thirds be made to open as a French window, to afford egress and ingress into the verandahs.

The long upright windows should be divided into three portions, or sashes, each of which should open upon hinges placed on the lower edge by means of a lever and pivot. The wall edges of all the window spaces should be bevelled away towards the ward, for the purpose of spreading the incoming air: and under the centre of the head of each bed an air-grating should be placed in the wall beneath the floor, having a aperture of not less than 12 x 8 inches; from this a galvanized iron square tube should pass to the foot of the bed; in the upper surface of this two gratings should be placed, one under the centre of the bed and one under its foot.

Whenever an end window can be placed in a ward it should not be omitted, as it adds to both ventilation and cheerfulness.

Mr. Trinnell's double circular tube should be placed in the wards on the upper floor, where the temperature of the roof space, and facility of placing it, render it most effective.

The windows should possess a simple mechanism for opening and shutting which places them beyond the control of the patients, and in this climate should never be quite closed; in medical wards they can, if necessary, be provided with fixed diffusion screens of perforated zinc or wire gauze.

There may be at various points in the wall air shafts or flues

discharging above the roof level, and ventilation may be still further assisted by a considerable number of small air grids or channels, built in the walls at short intervals, close to the ceiling. These grids should have a sloping lip on the inside, projecting about five inches from the wall, with an inclination of about 45° to prevent the falling at once in a cold volume to the lower part, of the ward. A corresponding grid should be placed in the opposite wall in each case. In this arrangement the air appears to take a direction generally across the ward, near the ceiling, and, being admitted in very small quantities and at numerous places, diffuses itself without perceptible draughts, displacing the heated portions of the contained air which naturally rises to the top.

It will, however, be necessary to provide one or two open fire places in each ward, according to its size. These may occupy a position in the centre of the floor, as in the Herbert Hospital: or in the side wall, as in the Chorlton. In the former, under-current flues are required; in the latter, the ordinary chimney is used.

The shape and proportion of exceptional rooms or wards will in all climates require special ventilation, but small wards require more superfical area and cubic space per bed; in these it should be about 2500 feet. This necessity arises partly from the severe nature of the cases which are usually placed in them, and partly from the greater difficulty of ventilating them.

In the development of this plan I have endeavoured on the one hand to avoid violent draughts while a generally diffused current is sought to be established through every part of the ward, and a strong glaring light avoided.

Reliance has also been entirely placed upon natural ventilation under a conviction that the mildness of our climate renders the admission of heated air to the wards unnecessary during any season of the year.

This is perhaps the best point for alluding to the nursing department; and I cannot do better than quote from the report of Messrs, Bristow and Holmes to the medical officer of the Privy Council. Their excellent and brief observations are as follows :—

"The comfort and welfare of patients in hospitals (or elsewhere) depend in no small degree upon the amount and kind of nursing which they receive. The good which a nurse is capable of effecting, and the evils which result from the employment of careless and incompetent nurses, cannot be expressed numerically, but that they are very considerable is unquestionable. The truth of this every one competent to form an opinion has always fully conceded; but to Miss Nightingale is undoubtedly due the credit of having taking measures to improve in a variety of ways both the system of nursing, and the quality of those who have to perform the duty of nursing. We do not propose to discuss at

length the question of nursing, but simply to give our opinions on certain points in regard to it—which have impressed themselves upon us in the course of our inquiry.

"1. We need perhaps scarcely express the opinion, that nurses of civil hospitals (except possibly in certain special cases) ought to be women. The peculiar instincts and moral qualities of the female mind especially adapt women for ministering to the wants of the sick.

"2. The duties which nurses have to perform are important duties, and ought only to be entrusted to women of certain character of mind. A fish-fag, a hawker, or any person habituated to a coarse or debasing kind of life, is evidently neither by education nor habit fitted to become a nurse.

"3. But neither is every women of refinement suited to fulfil the functions of a nurse. She may have a dislike to the work, and, if so, can scarcely be expected to carry it out promptly; or she may be devoid of some of those special feminine attributes which combine to constitute the thorough nurse.

"4. No woman, however admirably adapted by nature to be a nurse she may be, can be an efficient nurse without some experience, or some special training.

"Assuming the truth of what has just been asserted, assuming also (what is in fact unquestionable) that competent nurses are required in large numbers by hospitals and infirmaries throughout the whole of Great Britian, we arrive strongly at the opinions.

"1st. That nurses should be especially educated. It is only of late years that medical men have been required to undergo a course of instruction in a hospital; and at the present time it is acknowledged that no man is competent to act as a physician or surgeon who has not been specially educated for the purpose; and further, that no large hospital is efficiently worked without it has associated with it a class of medical students. All this is applicable to the question of nursing. Nurses have not, it is true, been hitherto specially educated; but they ought to be educated; they ought to be educated in hospitals, where alone they can have adequate instruction; and we are satisfied that this course, systematically pursued, will gradually tend to elevate the character and position of nurses, and that a school of nurses will bring with it to the institution to which it is attached analogous advantages to those which accrue from a school for the education of medical pupils. The Nightingale Fund has, for two or three years past, been partly expended in a system of educating nurses at St. Thomas's Hospital. The plan has succeeded admirably well in that institution; and we are bound to add that in the course of our visits to the provincial hospitals we frequently met with nurses who had received their education there, and we were invariably assured that these nurses were in all respects far above the average

of ordinary hospital nurses. An institution for training nurses has been established in connection with the Liverpool Royal Infirmary.

"2nd. That nurses should be relieved of all duties but those strictly belonging to their office; that, for example, it should be no part of their duty to perform the functions of a scrubber, and that they should not be expected to do more work than common sense and experience shows that they are physically capable of doing efficiently.

"3rd. That they should live on the premises, and board there, and that they be thoroughly well cared for.

"We may add that we are equally of opinion that private nurses (of whom vast numbers must be needed) should receive a hospital education. A training establishment for such nurses has been established at the Bath United Hospital; and we hope to see the day when most of our large hospitals shall have attached to them not only medical schools, but schools for the education of both hospital and private nurses."

It only remains that I should add to these observations an estimate of the number of a hospital nursing staff for a general hospital in Sydney. This should consist of a lady superintendent; a staff of sisters, in the proportion of about one to every thirty patients; trained nurses, in the proportion of about one to every ten patients; cleaners, and cooks; one wardsman for the male syphilitic ward, and from two to four bath and carrying porters are also required.

A CONVALESCENT HOSPITAL, strictly speaking, should be devoted to convalescing patients, and be considered as a branch establishment of the general hospital; but in a comparatively small community like this it will probably be desirable, as it undoubtedly would be economical, to place in it many chronic cases of disease.

It is evident that patients afflicted with many forms of chronic disease, as well as those convalescing from acute attacks, do not require the same frequency of professional visits, the great nursing care, or the variety of appliance in treatment which those suffering from acute disease and severe injury demand. It is unnecessary, therefore, that they should occupy the valuable beds of the more expensive central town hospital.

I am induced to recommend that the two classes (convalescent and chronic) should be accommodated in the same establishment, though in separate buildings, because—

1st. They require a similar degree of professional advice and attendance, and a similar character of diet.

2nd. They both benefit by having more extensive grounds for exercise than can usually be obtained in town.

3rd. The original cost of erection, and the annual cost per occupied bed in a hospital for the reception of both these classes,

should be less than it is in a central hospital, and the same principles of construction will, to a great extent, hold good in both.

I shall therefore consider it accepted, that the one establishment may be a compound hospital, consisting of two departments—1st, for convalescing patients; 2nd, for chronic cases; and that each of them should be divided into male and female quarters.

The requirements of the department for convalescents will be—abundance of fresh air, with ample space for exercise and light occupation, good diet, repose, and, to a great extent, the substitution of quarters having more the character of a home than a hospital.

The chronic cases should be arranged in wards of moderate dimensions, placed in detached pavilions, of not more than two floors, and should have some of the characters and fitting of a central hospital, but they need not be of so complete or expensive a nature. The limit of two floors is recommended, because land is less valauble in the country than in the locality of a central hospital, and for the reason that patients suffering from chronic disease, or in the convalescing stage of recovery from acute disease, are capable of availing themselves more freely of exercise in the recreation ground. Both departments should be fitted with earth closets throughout. A resident medical officer and dispenser will be required for the entire establishment, and occasional visits should be paid by members of the staff of the central hospital.

Invalid carriages, of proper construction, would be required to convey the patients from the central hospital, by railway, to the convalescent establishment.

I doubt if our experience of convalescent hospitals is sufficient at the present time to enable us to speak positively as to the exact form which they should take. Miss Nightingale is decidedly in favour of detached cottages, and she gives a plan of one upon this principle, which was to be built in the county of Wilts. This appears to me to be excellent as far as it goes, but to be unnecessarily ornamental and elaborate, especially for a young country where the expense of building is very great. A second specimen represented in her work is that of the male convalescent hospital at Vincennes. This is a most ingeniously arranged structure, and one upon which much thought has been expended. It is, moreover, said to be successful, after four years' working.

From these instances, and a careful consideration of the class of patients to be accommodated, the nature of the climate, &c., it will not be difficult to elaborate designs for such a hospital as that indicated; and I need not, therefore, trouble the society with further suggestions upon this branch of our subject.

The grounds of a general hospital are an important feature of the establishment, and the manner in which they are kept is usually a sure indication of the administration within.

The object of having more or less space enclosed beyond that occupied by the buildings is twofold:—1st. To afford free external ventilation, and prevent the encroachment of other buildings which could in any degree keep the wind and the rays of the sun from the walls of the building. 2nd. To afford cheerful and healthy recreation grounds to the patients who can leave the wards.

The first requirements will be great or small according to the site selected. If in the country, for instance, away from habitations, little would be necessary, unless fears were entertained of future encroachment; so also, if the hospital was to be erected within a public reserve, or at the edge of one, no provision would be required for the purposes of ventilation, &c.

The second object for which ground space is required is to afford means of recreation and exercise to the patients. It is evident that the extent required for this purpose will depend, in a great measure, upon the size of the hospital, and the nature of the cases to be received within its walls. If in a hospital of say (300) beds, the patients are to consist of a considerable proportion of chronic cases, the grounds may extend to some acres; but if acute cases only are to be treated, capacious verandahs, with an acre or an acre and a half of land judiciously arranged and planted, will be the utmost they can use or enjoy.

It should be a principle of hospital management that everything should be under active supervision and control, kept in perfect order, and managed with strict regard to economy; superfluous ground, therefore, in this form of hospital is undesirable. By all means ensure the full quantity that can in any way be beneficial to the patients, and keep it to perfection, but decline more than this.

Such appear to be the requirements of a central general hospital to be built in the present day. In considering them, I have endeavoured to select such as are necessary to embody the demands of modern medical science in the most efficient manner compatible with economical management, and convenience of administration, and at the same time such as are best suited to a climate like that of Sydney.

The question of expense it will be difficult to arrive at; but through the considerate kindness of Miss Florence Nightingale, I am in possession of the specifications of two modern hospitals, each of which must be considered a model of its kind. The first is the Herbert Hospital at Woolwich, and is notorious as the finest specimen of hospital architecture possessed by Great Britian, as well as that in which expense has been most disregarded.

The second is that of the "Chorlton Union," in Manchester. This is becoming almost equally well-known, as one in which "the most careful regard has been given to all those sanitary arrangements which it was thought might contribute to the alleviation of

the sufferings of the inmates,"* and in designing which the principles of economy are strictly regarded.

The cost of the Herbert Hospital was as follows:—

Purchase of land	£6,394
Hospital buildings, including the washing estabishment	209,139
Water reservoirs	5,351
Total ...	£220,884

The number of beds 650, so that the cost per bed will be from £339 to £340.

The cost of the Chorlton Hospital is calculated to be £30,000 including the land. The number of beds being 480—this gives the cost of each bed at £60.

It appears that the present tendency in England and France is to run somewhat into useless and extravagant expense in these matters. It should never be forgotten that the trustees of charitable funds are morally bound to do the largest amount of good with the money placed at their disposal, or that it is false kindness that affords extravagant delicacies to those wholly unaccustomed to them.

No hospital, strictly speaking, requires architectural pretensions, luxurious fittings, or extravagant management; but every such institution does demand that the most careful regard should be given to all sanitary arrangements, which can in any degree contribute to the alleviation of the sufferings of the sick.

Before leaving the subject of hospitals, I beg to suggest the establishment of one for cases of consumption at Port Macquarie. The experience at the Sydney Infirmary, and my own in private practice, affords the saddest and most ample testimony of the want of such an institution. Persons are constantly arriving from Europe suffering from this dread disease, and I have no hesitation in expressing my opinion that the climate of Sydney is unfavourable to its treatment, and that Port Macquarie is better suited as a residence for phthisical patients.

It should also be borne in mind that the wards of a general hospital are most unfavourable for the treatment of phthisis.

If a hospital for consumption was established, it might, I imagine, if judiciously managed, be made partly self-supporting, and would in any case be an immense benefit to the community.

In respect to the third division: of the hand-working class which requires relief, and which corresponds to the class provided for in the workhouse hospitals in England.

The experience of late years appears to prove that a large and

* Mr. Thomas Worthington on the Pavilion Hospital at Chorlton Workhouse

rapidly increasing class exists in the colony which is not provided for in the hospitals just mentioned. The immigration of a large number of persons in adult and advanced life, possessing few, if any, family ties in this country; the number of persons who do not possess a fixed habitation; the general absence of thrifty habits; the solitude and monotony of country life and occupation,—such are some of the influences which are rendering many of the lower orders friendless and helpless, and making them willing, if not anxious, to obtain a refuge at the hands of charity or of government.

For this class it is necessary to provide accommodation in the form of one or more infirmaries, which should be distinct from the hospitals, and capable of being conducted at less proportionate expense.

The necessity for such institutions is every day becoming more pressing; but they should be constructed and supported entirely at the Government expense. They do not, therefore, require further attention in a paper like this; but I may observe that, as the convalescing patients and chronic cases should, for sanitary reasons, be removed from the city, it is even more important that the infirm should be provided for at a distance from the metropolis.

But, wherever they may be placed, their support should cost the country less per head than the inmates of the convalescent hospital.

It follows, therefore, that all chronic invalids should be drafted from this establishment to the infirmaries when they have ceased to benefit from treatment.

We have next to consider the nature of the site which is best suited to the requirements of the two forms of hospital under consideration.

The commission appointed by the House of Commons for improving the sanitary condition of barracks and hospitals state, in their report, that the great points to be secured in the construction of hospitals are—1st, purity of external atmosphere; 2nd, abundance of pure air and sunlight within the building; 3rd, facility of administration and discipline.

Applying these principles to Sydney for the purpose of a central general hospital, it will be necessary that the site should be upon the summit of a hill capable of perfect drainage, and possess a dry soil. It should be either within some one of the public reserves, or at the edge of one, having a free space, if possible, upon the other side, occupy as nearly as may be a central position to the population. A considerable tract of adjoining vegetation and undulating ground, with varied and cheerful scenery, will be material and substantial advantages.

The site for a convalescent hospital should be at such a distance from town as will fulfil the following requirements.—

1st. It should be far enough to afford such a change of climate, and atmospheric influence, as will beneficially react upon patients convalescing from severe illness endured in the central hospital.

2nd. It should possess a climate and temperature that will suit the majority of its future inmates, and tend to the recovery of the largest nnmber of sick persons in the shortest possible time.

3rd. The foregoing features being secured, it should be upon a line of railway, and as near the metropolis as possible, for the purpose of securing efficient supervision—the periodical visits of a consulting medical staff, and be convenient for occasional visits from the friends of patients. Too great a distance would induce a serious reluctance upon the part of patients to go there, however much such a step might be to their advantage.

The suitability of existing institutions to meet the foreging requirements now demands our consideration, and first upon the list stands the Sydney Infirmary. This institution is situated on the summit of a hill; its grounds adjoin the Domain to the east, which, in its turn, is bounded by the waters of Port Jackson, beyond which again extends the Pacific Ocean. Upon the west it has a broad street, and commands a view from its verandahs of the entire city, with the distant Blue Mountains.

It is bounded at either end by Government buildings, and the ground measures about 350 feet square.

It is freely exposed to the sea breeze; and I am disposed to consider this favourable to the treatment of the majority of cases of acute disease and severe injuries, and it undoubtedly is a ventilating power of the highest importance.

Finally, it occupies a position in the city convenient to the shipping and wharfs, and more central to the population than any other with which (being otherwise equally favourable) I am acquainted.

Taking all these advantages into consideration, it must be allowed that it would be scarcely possible to find in any part of the world a more suitable site for a Central Hospital of a given size than this, and I have been unable to meet with any arguments in hospital literature which would in any degree justify a community in relinquishing it.

The original buildings of the Infirmary were well designed for the purpose they were intended to fulfil. But structures have been added from time to time until a considerable portion of the enclosed area has been covered.

At the present these consist of—

1st. Buildings of one floor at the south front gate, and a corresponding structure at the north front gate; these are substantial and in good repair, but badly designed, and cover a large proportionate ground space, affording also very inefficient accommodation for the pupose for which they were intended.

2nd. Bath-house and closets, with an office also in the front; these are small dens, adherent to the wall, and under any circumstances should be removed.

3rd. A very dilapidated shed-like building at the north-east corner, used as a dead-house, and post mortem apartment, with a shed in which the hearse is kept, &c.

4th. A primitive structure of solid and excellent stonework, containing two cells for lunatics; the walls, roof, and division wall, are all three feet thick, and there are no windows or ventilation; this curiosity is at present the receptacle of lime, &c.

5th. A cottage at the south-east corner, in which the messenger his wife, and family, have endeavoured to reside; but repeated attacks of fever have induced the directors to have it closed.

6th. A conspicuous and rather ornamental pile of building in the centre of the grounds, containing water-closets and urinals; this is favourably placed for purposes of scandal, in an institution containing men and women, and should be removed.

7th. A two-floored building, also in the centre, embracing the kitchen, scullery, laundry, and coal-hole; this is repaired in every direction, and cannot hold together much longer.

8th. The Nightingale Wing. As far as I can judge, this building is well arranged, and adapted for the purpose for which it has been built. It is intended to provide accommodation for the entire nursing and housekeeping staff, while provision has also been made for a sufficient number of sisters and nurses in training, for the supply of the various country hospitals. It also contains linen store, mending room, private kitchen, &c.

This building has received the unqualified approval of Miss Florence Nightingale, and its existence must be held as some argument in favour of the retention of this otherwise excellent site for a central hospital.

9th. The south wing is a substantial good structure, and is now receiving considerable additions in the form of rooms for the superintending sisters, water-closets, bath-rooms, lavatories, &c., together with an outside staircase for the isolation of each floor. When these are completed this wing will embody all the substantial advantages of a modern hospital pavilion.

It may, however, be remarked that, although it was built within the last ten years, and much care was taken in preparing the plans of the recent additions, the difficulty of adapting them to a structure not originally intended to possess them was very great. This pavilion will have cost—when the additions are completed—from nine to ten thousand pounds, and affords accommodation for abont 80 beds, but the close proximity of the quartz-crushing machinery and smelting furnace chimney of the Mint are serious incouveniencies which ought to be removed.

The main front building was erected for the purpose of a convict hospital. It consists of eight wards on two floors, each measuring about 60 feet long, 24 wide, and 15 high; two staircase and entrance halls, and verandahs all round both floors. The ground floor is raised about 4 feet, the walls are faced with square cut stones, I believe about six inches thick, the remaining substance of the wall being formed of rubble stone. The general plan of the building—and the selection of its glorious site—speak highly for the judgment and enlightened views of Governor Macquarie. Sixty years have, however, now elapsed since the building was erected, and it has done its work—first as a convict hospital, then as a store, and finally as a general hospital. Science has also made rapid strides, and the building—not originally adapted to the purposes of a general hospital—has become wholly incapable of meeting the requirements of the present day. It contains beds for about 112 patients, but only one of the wards possesses a water-closet, and none of them a lavatory or bath-room, sink, attendants' room, or scullery. The windows provide inefficient ventilation, and cannot safely be altered. The floors and stairs have required constant repairs, the roof is faulty, the drainage is altogether defective, and passes beneath the centre of the building.

Such is the present state of the Sydney Infirmary. It occupies one of the finest and most convenient hospital sites in the world. It possesses a substantial, well arranged modern pavilion wing for eighty patients, and the Nightingale wing will have accommodation for a complete nursing staff for 300 patients.

Lastly, the decayed and inefficient front building occupies an unequalled site for a memorial hospital, capable of receiving 200 patients, and of relieving the ground of most of the small detached buildings which now encumber it.

The difficulty of altering and enlarging the main front building of the Infirmary exists in the form of the structure, which although well designed for the special circumstances under which it was designed, renders it impossible to make provision for the requisites of a modern hospital for severe cases, without breaking the line of wall in no less than five portions of the front and back of the building, causing no less than sixty angles,from which the sun and wind would be more or less excluded. The great inconvenience of this has been rendered more evident since the alterations of the south wing have been in progress.

The abovementioned is not, however, the only drawback. It would still be necessary to reconstruct the detached buildings now upon the ground, and raise the present front structure at the north and south front gates, and erect an additional one behind to provide for small special wards and an efficient operating theatre.

The windows of the front building would also require enlarging upwards and new ones would have to be formed.

Finally, the roof and flooring must be substantially repaired.

These alterations and additions must be accepted as the least that are necessary, and they will cost not less than £14,000.

Their adoption would not, in the opinion of the committee to which the duty of considering and reporting upon them was entrusted, be in any degree satisfactory.

The new St. Vincent's Hospital, now in course of erection near the Darlinghurst gaol, will, I am informed, provide accommodation for eighty patients when complete; but only one-half this number is included in the present contract.

Judging of the structure by the portion already build, I am unable to understand how it can be made to fulfil the requirements of a modern hospital. The site can hardly perhaps be considered a bad one, but it appears to me that the recreation ground is very insufficient. The bath-room and lavatories are good, and provision is being made for excellent verandahs.

The accommodation will be available, more especially for the surrounding locality and the members of the Roman Catholic Church.

I am not aware of any other existing hospitals which require our consideration, but the building upon the Quarantine Ground deserve notice because it has been objected that if the front Infirmary building were taken down, the difficulty of providing for the patients during the erection of a new structure would be a serious evil. This objection is a valid one, but I think that the suggestion of "Civis" would relieve us of any serious difficulty in the matter.

The various cottage pavilions upon the Quarantine Ground appear well suited to receive temporarily 200 chronic and sub-acute cases, and convalscing patients, if a small sum of money were expended upon them, and arrangements made for conveying the patients from Sydney. The spot is undoubtedly salubrious, and if the Government would cansent to the temporary use of it as a hospital—great expense and inconvenience would be avoided by the arrangement.

There is still one more point which has not yet been dealt with I allude to the topographical features of the locality.

Sydney stands upon the edge of a harbour unrivalled for its. beauty and the number of its arms and bays. This characteristic feature, together with the general distribution of the sandstone formation, must always render the city comparatively healthy, and materially lessen the propability of any large extent of dense population. The tendency of the residents to diffuse themselves through the suburbs would appear at first sight to be a reasonable

argument in favour of detached hospisals in various localities, but it really is a strong reason reason for one well appointed and complete institution.

It must be evident that several separate establishments cannot be built, efficiently managed, provided with a suitable staff of honorary medical officers, and supported by public subscriptions with a population so limited as ours, and I infer, therefore, that it will be preferable at the present time to limit our efforts to the satisfactory completion of that which already exists, and occupies a site which, for general convenience and healthiness, certainly cannot be supassed.

It will propably be necessary at some future but distant period to provide a second general hospital in such a position as will, as nearly as possible, be central to the most popular district in the south-western direction.

Having thus considered the subject in detail, it remains that I should state the conclusions to which the investigation has led me. The references which I have drawn are:—

1st. That the present is a favourable period for developing a general scheme of hospital accommodation, and that all future expenditure should only be made in furtherence of this view.

2nd. That such a general scheme should comprise—

a. A hospital for acute cases, situated in a central position in the metropolis.

b. A hospital for the convalscing and chronic cases, situated upon the line of railway, at such a distance from Sydney as will ensure a more bracing climate, freedom from the sea breeze, and facility of management.

c. An infirmary, also placed in the country, for the reception of all persons of the hand-working class who may have become permently infirm.

3rd. That the circumstances of the colony have caused a rapid increase of persons whose infirmities of health render them more fitted for relief in Government establishments than in hospitals supported by voluntary contributions.

4th. That the first consideration of those who desire to deal with this subject should be the provision of efficient accommodation for the acute cases.

5th. That acute cases of disease and severe accidents should be accommodated in one or more hospitals, occuping a central position in the metropolis, and affording a present aggregate of about 350 beds.

6th. That the site of the Sydney Infirmary is well adapted for the purposes of a General Central Hospital, and that the existence of the south wing and Nightingale wing renders it desirable that it should be retained as such.

7th. That a large portion of the ground belonging to the Sydney Infirmary is at present occupied by numerous small detached buildings, the accommodation now contained in which might conveniently be placed in a new front building.

8th. That the present main front building is not suited to the requirements of a modern hospital for the reception of acute cases—that it cannot be converted into such, and that it will be an ultimate economy to rebuild it at once.

9th. That the new structure should consist of a centre, with two adjoining wings, having a basement and three floors—that the centre and basement should contain all the administrative accommodation, and the two wings be devoted to wards.

10th. That the establishment thus remodelled will be equally efficient for the reception of acute cases of disease and severe accidents, &c., for all the purposes of a school of medicine such as that proposed, and as a training school for sisters and nurses for the country hospitals.

11th. That a small hospital for the reception of patients suffering from consumption, should be established at Port Macquarie.

12. That the cases now treated in the lying-in wards of the Benevolent Assylum should be transferred to the country, and be accommodated in detached weatherboard cottages in connection with the Infirmary.

13. That the utmost efforts of charity among the inhabitants of Sydney and its suburbs will not be capable of supporting a convalescent hospital, or for some years to come a third Central General Hospital.

Appendix.

The following extracts are from the Report to the Privy Council, by Dr. Bristowe and Timothy Holmes, Esq., 1863:—

"The institution of convalescent hospitals, that is to say, of hospitals in which patients shall be maintained for a short time after their recovery, until their strength is more completely repaired, is a charitable and wise provision, but one which is of more importance in a social than in a sanitary point of view. Considered in regard to the sanitary condition of hospitals, the chief effect of convalescent asylums would seem to be to facilitate the more early withdrawal of lingering cases from the wards, and thus to set free the beds for the treatment of acute diseases. We may hope that the scheme will be largely extended.

" Closely connected with the foundation of such institutions in connection with our London hospitals,—for such institutions will always be in the country,—comes the still more important question of the desirability of seeking a rural site for what are now metropolitan hospitals. The statements contained in this report, with

respect to the relative certainty and rapidity of cure from various diseases and injuries in town and country, will be found somewhat meagre and indecisive, but we believe they adequately represent the evidence which we at present possess on this vital question. What answer, then, should we be prepared to give to such a question as this: Suppose it possible to transport St. Batholomew's Hospital as it now is, and with its present supply of patients, from the heart of the city into the heart of the country, what would be the results on the prospects of individual patients.

"Our deliberate opinion is that the effect, if any, would be very trifling. That there might be some slight variation in the mortality may or may not be probable; but that the prevalence of hospital disease would much decrease, that operations on given cases would be much more likely to succeed or that the period of recovery of given cases would be much more abridged, we do, judging from the evidence before us of the state of things in hospitals variously circumstanced as far as situation goes, utterly disbelieve. In fact, we have no evidence which shows that any change at all would be wrought in any one of these three particulars.

"But if the effect of the removal were to change the supply of patients, whether as to the nature of the cases, or as to the class of persons admitted,—if instead of a large proportion of dangerous accidents and acute diseases, the practice of the hospital were to lie chiefly among chronic invalids and convalescents,—or if, instead of the worn-out victims of want and debauchery, who are the principal subjects to injury and acute diseases in towns, the healthier inhabitants of a district were to become the inmates of the hospitals,—then there can be little doubt that the success of treatment would be considerably increased.

"Let us apply these conclusions to the most interesting and important of the questions which are at present agitated with respect to town or country hospitals, viz., whether it is possible to treat the sick of the metropolis or other great cities in hospitals situated in the country, and whether the benefits which would probably be derived from such a course are equivalent to the inconveniences which it would certainly involve? In answer to this we may state, that we believe it to be impossible to treat the sick poor of a great city anywhere except near their homes, at least those of them who are most seriously ill, and who, as we have contended all through this report, are more especially the objects of treatment in our large hospitals. The experience of St. Thomas's Hospital is in point on this matter. The removal of the hospital from the Borough to the Surrey Zological Gardens in Walworth was a much less extensive change than the one we have supposed. The new hospital was within walking distance of the situation of the old one, so that no country journey or rail-

way fare prevented the patients being visited by their friends. Yet the change in the class of cases is manifest, as is also the increased pressure upon the beds of Guy's Hospital. Now in any scheme for a country hospital to receive the patients of a city, there must always be left in a city a depot for the acute cases and grave accidents not admitting of the transit.

"The pressure upon the resources of this latter would therefore increase; and above all, if fever were received, there would be much risk of it becoming a fever-house only, or only a fever-house with a separate department for accidents. The country department would then become what our country infirmaries now too often are, viz., a receptacle for chronic invalids; and the acute non-febrile cases would be left without hospital accommodation. This would be a very grave evil, nor is it easy to be satisfied, from our investigations, that it would be compensated by any corresponding benefit. If it seems probable that hospital diseases are relatively as common, and recovery neither more certain nor more speedy in the country than in the town, to what purpose should the hospital be moved and its existence as a school of medicine and surgery thereby endangered?

"There is, however, another view of the question, which is well worth consideration, and which we are glad to say is now obtaining the prospect of practical experiment, viz., the advantages to be derived from attaching a country department to a large London hospital, partly as a subsidiary hospital and partly as a convalescent charity.

"The effect of this would probably be not only different from but even opposite to that of removing the bulk of the hospital into the country, and leaving only a small receiving house in town; for patients, knowing that they would have the option of remaining in town if they choose, would of course be attracted by the offered alternative of a gratuitous sojourn in the country.

"Again, the opportunity of sending away from the metropolitan hospital a large portion of the less urgent cases would enable the governing body of the hospital to relieve the same number of patients, with a considerable diminution of the number of beds in the chief hospital. Now if our hospitals present one defect more conspicuous than another to the eyes of the attentive observer, it is that of overcrowding. We believe that at most hospitals (metropolitan and rural, particularly the latter) the beds are too close together. The proposed scheme would give an opportunity to remedy this defect, while it would withdraw the less seriously affected patients from the influence of the hospital diseases which prevail among a number of severe surgical cases, and of the fevers which most of our metropolitan hospitals admit. On every ground we think the experiment well worthy of a trial, and we have much pleasure in quoting from a report issued by a com-

mittee of the governors of St. George's Hospital, appointed to consider the question of founding a convalescent, or perhaps we ought rather to say, a subsidiary hospital in the country, in connection with that hospital. The committee recommend the foundation of an institution that possesses all the requirements of an asylum for the convalescent, whilst it embraces those of a convalescent hospital to which patients whose cures have not been completed can with safety and advantage be removed where their cures would, by change of air, be accelerated, and where, in many instances, cures might be effected of diseases and accidents, which, when left in London, might terminate otherwise, and where persons recovering from infectious diseases might remain until all danger of carrying infection to their homes had passed away. The advantage of such an institution would not be limited alone to those patients more immediately benefited by it, but the beds in the hospital would be much more rapidly emptied than at present; thus enabling a larger number of patients to be treated without an increase of expenditure: in fact, such an establishment would in reality be a portion, so to speak, of the hospital in the country.

"It is quite unnecessary in the present day to put forward any arguments as to the expediency of a certain class of cases, or rather of diseases and accidents in certain stages, being treated in the country rather than in London, however well a hospital may be located. Even in Saint George's Hospital, unrivalled for its situation in this or any other city, in a ward well placed for air and ventilation, one of the scourges of surgical disease (phagedæna, sloughing of sores and wounds) has been exceedingly prevalent during the past season. To be enabled to send patients away for the further treatment they may require, when such a disease makes its appearance, would certainly result in the saving of many lives.'

"It is quite possible that some such plan as this will be found to be the best method of uniting the advantages of both town and country situations, but the scheme is as yet untried."

Since the foregoing paper was written, I have received the following note from Dr. Renwick :—

My dear Sir,—I have just received your note, and hasten to furnish you with the particulars you request.

In the first place, you will find on blank page the statistics of accouchement cases. I regret to inform you that it would take a long time to discover the number of infants who died at or shortly after delivery, and hence I cannot give you an accurate return under that heading; it could, however, be furnished if I had time to go over the whole of the medical returns. From tables which I drew up for another purpose last year, I know that the average

infantile mortality (including still births, and deaths within one fortnight after births) is about *one in eighteen.*

Hoping that these particulars will answer your purpose,

I remain, yours &c.,

ARTHUR RENWICK.

Elizabeth-street, Hyde Park.

ACCOUCHEMENT CASES.

	Number.	Deaths.
1863	104	1
1864	107	0
1865	129	0
1866	129	0
1867	121	0
Total	590	1

N.B.—Of the mothers, two-thirds, were unmarried women ; *and three-fourths of the women were primiparas.*

Comparing this result with that of the largest lying-in hospital- in the United Kingdom—the Rotunda of Dublin—we find that the balance is considerably in favour of the lying in wards of the Benevolent Asylum in Sydney.

Against one death in 600 in the latter, we find that the average mortality in the former is 1.5 ; yet this institution is described by Messrs. Bristowe and Holmes as "That admirable institution, admirable alike in its construction and in its arrangements."

This satifactory result of the management at the Benevolent Asylum does not, however, afford any argument against the removal of the wards to a healthy country site, as proposed ; in fact, to the adoption of that character of accommodation which is considered in England to be best calculated to ensure the lowest mortality.

ART. IV.—*On the Causes and Phenomena of Earthquakes, especially in relation to shocks felt in New South Wales, and in other provinces af Australasia, by the Rev. W. B. Clarke, M.A , F.G.S., V.P.*

(Read 2nd September, 1868.)

THE subject of earthquakes is one of intense interest, not merely to the moralist, but to the investigator of nature. As such, it very early in life invited my attention, and to it one of the first essays I ventured on in connection with geology was dedicated. That was five-and-forty years ago. Ten years later I commenced a series of papers, which were published in " Loudon's Magazine

of Natural History," during 1833, 1834, and 1835, "On certain (then) recent meteoric phenomena, vicissitudes in the seasons, and prevalent disorders, contemporaneous, and in supposed connection, with volcanic emanations," in which, of course, earthquakes had their share.

Subsequent discoveries have, no doubt, modified some of my views and deductions; but it was from a familiarity with such topics, that I ventured to accede to the request made to me at our July meeting, that I would discuss the phenomena of the earthquake which shook the country on the 18th June last.

This I have now connected with all the other recorded shocks in Australasia, felt since the foundation of the colony to the present time.

In treating on so much more extended a subject, I consider it necessary to enter at considerable length into certain explanations of the theoretical origin of earthquakes, and to mention the facts that have been observed in relation to their character.

It is, however, first of all, necessary to give a definition of an earthquake, which, for conciseness, I select from Mr. Mallet's Essay in the *Admiralty Manual of Scientific Enquiry* (p. 207). He defines it to be the transit of a wave of elastic compression in any direction, from verticality upwards to horizontality in any azimuth, through the surface and crust of the earth, from any centre of impulse, or from more than one, and which may be attended by tidal and sound waves, dependent upon the impulse and upon the circumstances of position as to sea and land.

As some persons assume that it is to earthquakes alone the elevation of portions of the surface of the globe is due, it will require a certain amount of investigation of the principles laid down by seismologists, before we can show how far such an opinion is or is not supported by evidence.

As, moreover, an elevation of our own coasts has been conjectured to be still going on, a brief investigation of the kind may not be out of place on the present occasion, although it may be well to premise, what will again be alluded to, that the effect of earthquakes is generally rather to depress than to elevate. Fortunately, the subject of elevation in connection with earthquakes has been successfully treated by a physicist of high order, my late friend, Mr. Hopkins, of Cambridge; whilst the general facts of the phenomena of earthquakes have received great illustration from the labours of Mr. Mallet, of Dublin. To both of these sources I shall apply in the course of my remarks, as well as to other authorities deserving notice, in preference to any crude or undigested arguments resting solely on my own views or calculations.

It would be impossible to discuss the earthquake of the 18th June, and those which have preceded it since the Colony was

founded, till certain principles have been referred to; and these must necessarily be maintained on the basis of the arguments by which they have been established. We shall be safer in this way than in any other; and to some of the members of this Society, it may be satisfactory to have the subject so initiated. When we consider that the literature of earthquakes extends already to upwards of 2000 separate publications in various languages, it may be better to avail ourselves of the labours of those who have narrowed the field of research than to explore it anew in all its ramifications. Mr. Mallet, to whose paper I have made allusion, has given a catalogue of 500 or 600 works, enumerated by Professor Perrey, of Dijon (who has himself contributed nearly 60 distinct treatises) in the Memoirs of the Imperial Academy of Dijon (1845-6).

Undoubtedly, there is sufficient known to establish a relationship between the phenomena of earthquakes and volcanos. Facts justify the assumption that whether preceding, accompanying, or succeeding each other, eruptions and earthquake shocks are often mutually dependent on each other; and that they are so dependent as to imply that they must have a common source, in a fluid zone of matter with which steam and other gases are associated, at a greater or less depth below the earth's surface.

We have in this allusion been again brought face to face with the question partly discussed at our July meeting, viz., the evidence afforded to a theory of internal heat, by the fact arrived at in artificial or natural openings at great depths in the crust of the earth. Between the limits of 70 and 90 feet, with some exceptions, experiments have shown that the temperature in that ratio increases from the surface towards the centre in degrees of Fahrenheit's thermometer, allowing, of course, for the structure and conditions of the strata traversed. The latest reliable experiments are those detailed in the Anniversary address to the Geological Society of London, delivered by Mr. Warrington Smith, on 21st of last February. In Mr. Smith's remarks, I find a full confirmation of the opinions respecting earth temperatures which I ventured to express in our conversation in this room two months ago. And I am sure my learned colleague, the Astronomer, would be much interested in the details submitted by the accomplished geologist—Mr. Warrington Smith—of the curious facts observed in relation to experiments recently undertaken in France. From experiments by M. Walferdin these results were obtained. In two places in the coal field, near Creuzot (Soane and Loire), the experiments being conducted exceptionably, and for the purposes of scientific truth, it was shown that the earth's temperature varies at small distances. At Mouillelonge, the depth equivalent to 1° F., was 43.1 feet, and at Torcey, only two miles distant, it was 56 feet. Thus the tem-

perature of boiling water would be reached at $1\frac{3}{4}$ mile of depth, whilst in the deepest English shaft, that of Duckinfield, the depth would be $2\frac{1}{2}$ miles. Whilst, then, it is certain, that there is no normal depth equivalent to a degree, we have yet by these new researches a confirmation of a fact closely in relationship with the theory of a fluid zone of molten matter on which the crust of the earth is floating. Details of experiments of this kind are sufficiently numerous in scientific records, and works of popular geology give numerous results There is a very useful paper on this subject, in the 17th number of the *Journal of Science*, by my friend Mr. Hull. But it has to be noticed, that the proximity of a volcano has no necessary connection with this phenomenon, for the temperature of the well of Grenelle, at Paris, (1794 feet deep) is 82°, and that of Salzwerk, in Germany, (at a depth of 2281 feet), is 91°, whilst the Bath waters in England, rise with a temperature of 117°, and a spring at Arkanzas, in America, has that of 180° F., both probably proceeding from depths far below those of Paris and Salzwerk. Similarly, on the Flinders River in North Australia, where there is no immediate volcanic influence, there are springs which issue with a temperature of 107° F. On the other hand, it is recorded, that the deepest point to which the skill of man has penetrated, is the Pit Simon, at Gilly, near Charleroi, in Belgium, which is 3489 English feet in depth, and the temperature of it is only 78·8 F., whilst at the colliery of Grand Mombourg, at Montigny, at a depth of 2180 feet, the temperature was only 50° F., and at 1922 feet, 72·5 F. Should this be due to the temperature of the air, it will show how carefully experiments ought to be conducted if truth is to be arrived at.

That this internal heat has nothing to do with astronomical causes, has been satisfactorily shown by Sir John Herschel, in his paper in the Transactions of the Geological Society (2nd ser. vol. III.), read 15th December, 1830, in which he demonstrates that the causes of changes of climate in ancient periods must be sought elsewhere than in the relations of our planet to the system to which it belongs.

In a very elaborate discussion by Mr. Hopkins, that author points out that though the precession and nutation of sun and moon might exhibit alteration from their present condition, if the the earth's crust were much thinner, than it is believed to be; yet, as it is, it is not subject to influences from these astronomical conditions Nevertheless, Herschel admits that the sun and moon have a tendency to produce a tide in the solid strata of the earth, and would, were the crust fluid; as there is an influence in a tangential direction, causing a strain in the crust when the sun is on the horizon, and a pressure under the zenith. Still, all this does not affect the proposition, that the phenomena of volcanos

and earthquakes are independent of any considerable influence from external causes.

This problem was endeavoured to be solved by Hopkins, who assumed the structure of the earth under two or three supposed conditions.

The earth may have a solid or fluid centre, or it may have a fluid ring interposed between a solid centre and a cooled surface. Mathematically discussed, the following result is arrived at—that the crust of the earth cannot have a less thickness than 1-4th or 1-5th of the radius of its external surface, *i. e.*, about 800 or 1000 miles, more or less. The question as to precession and nutation is in relation to this result.

Notwithstanding these views, there are considerations which permit the opinion that the derangements in the interior of the earth may, in part, be due to interference of the sun and moon. There are, however, difficulties in the solution of Hopkins's problem in the third case which render it almost impossible.

By a paragraph in an English journal which arrived in July, it appears that observers had gone out to Vesuvius to ascertain whether the views of Signor Palmieri are correct as to the influence of the moon on the eructations of that volcano. The statements to that effect by Professor Perrey were submitted by the Academy of Sciences at Paris, to a Commission which has affirmed that for half a century earthquakes have been more frequent at the new and full moon than at the quadratures.

M. Zantedeschi's views go to the extent of assuming that there is a terrestrial as well as oceanic tide produced by sun and moon. But we have already heard the opinions of Herschel and Hopkins; and Mr. Mallet, who treats with caution the statements made, admits that sun and moon do influence phenomena in the earth; but, certainly the cause of eruptions and earthquakes must be sought within the earth.

The facts themselves relating to the temperature below the surface are various, and the actual mean ratio of depth corresponding with a degree actually undetermined; and it is easier to accumulate examples than to account for the cause of the heat. Still, the general assumption is generally considered in the main to be correct, that at a certain depth below there must lie a fluid zone, probably very irregular in its roof, so as to allow of cavernous places above its ordinary level; or a succession of reservoirs, either insulated or connected, in which the fluid is collected, in the solid crust.

Whatever may have been the original condition of the earth, it is impossible to deny the influence of pressure, and this, in Mr. Hopkins's view, is opposed to a moderate thickness of the earth's crust, such as Professor Bischoff admits, viz., one of twenty or thirty miles.

This latter author assumes that eruptions and earthquakes arise from the access of a column of sea or fresh water, by means of fissures, to the fluid mass below; and there are many circumstances which justify this as a sufficient explanation of certain examples. Tyndall has shown, moreover, how force may be represented by heat. Mallet also prefers a deduction from this to the idea of a crust floating on a molten base.

There is again what is called the Chemical theory, that of Sir H. Davy, which is supported by Dr. Daubeny, but opposed by Gay Lussac and Bischoff; and shown by Hopkins to be mathematically impossible. Davy assumed that water and atmospheric air have access to an unoxidised metallic mass, which becomes oxidised, so producing heat. The idea of such a metallic mass was strengthened by the fact that the mean density of the earth, taken in relation to that of water, is $5\frac{1}{2}$, and that many of the rocks have S.G. from 2 to 3, whilst that of metals ranges up to 21, from which it was concluded that there might be a mean S.G. for the central portion of the earth, equal, as assumed by some, to that of iron. Hopkins argues that the molten matter arising in the assumed fissures, would prevent the access of air and water; and Stromboli and Kirauea are quoted as evidence against it, because the lava has constantly stood fluid in them, at a height considerably above the level of the sea.

Another objection is stated by Lyell, in his new volume (p. 233). It was at first believed by some, including himself, that Davy's theory was insufficient, because *no hydrogen* was detected by him in Vesuvius. Hydrogen has, however, been detected since in considerable quantities; and M. Fouqué, in 1865, found that, during the eruption of Etna, no less than 22,000 cubic metres of aqueous vapour were daily emitted. But this was chiefly proto-carbonate of hydrogen, and not free hydrogen, which was concerned, according to Fouqué, whereas, if Davy's theory of oxidation holds good, an opposite result ought to be arrived at. Yet both Davy and Fouqué agree that water does probably obtain access to the molten fluid, and we have this fact to sustain Bischoff's theory so far, that live fish have been ejected during an eruption, proving the access of water; as well as the great amount of infusoriæ in the ashes covering the remains of Pompeii, which was destroyed by the ash eruption of Vesuvius in the year 79. It is said that great quantities of fish are ejected with torrents of water from a height of from 16,000 to 17,000 feet, during eruptions of Cotopaxi, Tunguragua, and Sangay, in South America. Sir J. Herschel, speaking of sudden explosive action among the extinct volcanos of Auvergne and Vivarais, says that the granite rocks are sometimes perforated without being shattered, as if water had been suddenly let in on a heated molten mass below, producing so violent and sudden

an explosion as to produce a similar effect to that of a bullet passing through a pane of glass. (*Familiar Lectures*, p. 40.) When a boy, I used frequently to see melted lead cast in plates, and lifted in a molten state from the furnace into a prepared vessel. On such occasions water was sometimes, in play, thrown in small quantities (a drop or two) upon the metal, and the instantaneous formation of steam was attended, at a certain stage of cooling, after the spheroidal state had passed off, by violence and detonation. Fouqué, however, adds that, if Davy's original theory is true, the heat evolved by Etna in 1865 would have required at least 7,000,000 cubic metres of sodium, and therefore an incalculable amount of alkaline metals, to have produced eruptions over the earth from the beginning till now. Lyell very justly remarks, that to sustain the chemical theory would require an amount of knowledge which is altogether unattainable. Louis Sœmann (now deceased, and who furnished me with the splendid collection of rocks and minerals in the Museum) remarks that heat would materially modify all chemical combinations, as in the case of mercury, which does not combine with oxygen at ordinary temperatures, but does at boiling point, and then throws it off at incipient red-heat; "and what is true of mercury is also true of all other elements."

M. Angelot between the years 1841 and 1843, read several papers before the Geological Society of France, in explanation of his views respecting the action of sea waters in producing volcanic phenomena. (*Bulletin, tomes* xiii, xiv, *et tome* 1. *d . s.*

M. F. Martha Beker, also, in 1858 explained to the same Society, how, regarding the definition of Humboldt as the only rational one as to earthquakes being the reaction of the interior of the earth on its exterior envelope, cooling and contraction of cavernous strata of a molecular condition between incandescence and imperfect solidification, producing changes at variable epochs, sufficiently explain all the facts, when connected with the combined action of subterranean waters converted into gas. (*Tome* xv. *d.s*).

In a learned Memoir of M. Boué, read in 1856, (*Tome* xiii, *d.s*) the author reveiws all the phenomena and the explanations of Hopkins, Perrey, and others, maintaining that earthquakes are in intimate connection with electrical and magnetic forces, (as illustrated by occurrences of Auroræ), an opinion by the way, which finds support in the writings of other and more recent authors, as well as in the notices of earthquakes by Arago and other contemporaneous and preceding philosophers. He seeks to combine chemical with magnetic affinities, but admits that some earthquakes may be due to the pressure of water.

It would be folly to deny the importance of the facts, or the weight of Boué's reasonings; but reviewing the great mass of

authorities, and still giving allowance to the undoubted operation of magnetic forces (connected as all physical agents are with one another) and even admitting that the spots on the sun, owing to their probable coincidences in relation to Auroræ and earthquakes (which is a view recently made prominent) indicate an influence upon the earth from without, yet it must be admitted that arguments are in favour of an occasional access of water to a molten mass below and to what is called "central heat," the steam thus produced after the spheroidal state of the water has passed rushing up and producing the *blow*. The vibrations preceding it are considered as due to the spheroidal condition, and the after vibrations as resulting from the motions impressed on the rocky particles.

The mathematician denies that these operations are limited to Bischoff's assumed thickness of 20 or 30 miles, and with this agrees a deduction (before mentioned) of Professor Tyndall (who refers to Hopkins and Fairbairn), that pressure produces heat—quoting the former, who says that the deeper strata would require a greater degree of heat to fuse them than the upper strata; and alleging that the heat of substances which expand on solidifying is *lowered* by pressure. In the opposite direction, this agency of hydrostatic pressure as producing earthquakes, has been advocated in a paper read before the Wernerian Society (November 14th, 1840), by the Rev. J. Toplis, who argues that the phenomena witnessed are generally explicable by such an assumption.

Lyell reminds us that the notions of the original fluidity of the whole earth belonged to an age when geologists held opinions that are now abjured as unsound. Granite was once considered of the highest antiquity, and the so-called crystalline rocks were held to be older than all the fossiliferous formations. We now know better, as I endeavoured to show in my paper, read before this Society in 1865, "*On the Transmutation of Rocks in Australasia.*" The doctrine of metamorphism or transmutation explains away a good deal of error respecting the formation of many rocks. The exposure of such transmuted portions of the earth's crust does not prove that the present crust rests on a universally consolidated base, but only that large tracts of upper beds have been denuded, and that the slow processes of change during long epochs, aided by water, have changed even fossiliferous deposits, which occasionally cannot be distinguished in character from such rocks as the older theorists believed to be the sole result of igneous action.

Mr. Hopkins argued that eruptions arise from the expansion of gases in the molten matter, as proved by the constant ebullition of Stromboli and Kirauea, and admits the evidence from sulphur and other mineral matters condensed on the sides of volcanic

vents. He supposes, therefore, that by the expansive force of the gases large surfaces of the earth's crust may be upraised and fissured, that slow elevation may take place during long-continued feeble action, and sudden elevation by paroxysmal action; whilst vibratory motions may be originated according to proximity or distance, and quantity of force employed.

Now, it must be remarked, again, that vibrations must also depend on various conditions; and that velocity, direction, extent of motion, and elasticity of substance, must be taken into the account of earthquake shocks.

All supposable cases are illustrated in Hopkins's Memoirs by diagrams, and the depth of the foci of disturbance he deduces from formulæ connected with the velocity ascertained between points well determined as to the instant of a shock along a given line of direction.

He assumes three conditions:—1. When the earthquake vibrations pass through a homogeneous mass. 2. When the formations traversed are variable. 3. When the sea overlies them.

He then shows that where a shock traverses a coast line at moderate depth, the velocity of motion is greatest in the solid crust, least in the sea, and intermediate in the subjacent molten fluid, and that the wave of motion is refracted in passing from one medium to another.

Supposing this to take place in a wide area, with considerable force, then permanent elevation might occur; but if the intensity be small, and only vibrations ensue, all points of the surface would be reached nearly at the same time, and the apparent horizontal propagation would be great, and, therefore, contemporaneous shocks over a large area afford the strongest proof of the original disturbance, although a stronger shock, acting vertically, and coming from a greater depth and a single centre might produce a greater effect immediately over the point of disturbance. Thus, also, a permanent elevation of the surface may take place where the area of original disturbance is great. To understand these views one must refer to the diagrams by which they are explained.

A stone thrown into water produces undulations which advance from the focus of disturbance in concentric sweeps, which may represent the passage of a shock, as that of waves rolling onwards all round. Now the front of such waves must be circular or elliptical, whether in land or water.

Suppose, then, a sudden elevation of the sea bottom; the front of the wave produced will be steep, and the posterior slope gradual, and this wave will diverge all round the point of disturbance, and be accompanied in water by a current. The velocity will depend on the depth; therefore if the wave pass through different depths of water, the front will not be circular,

but will represent what is called a tidal bore. If the elevation be slow, the wave will represent a breaker. Now, such waves are exhibited daily in our harbour, when a steamer coasts along the shore. The disturbance occasioned by the action of the paddle-wheels causes the water in advance of the vessel to rush towards it, in order to fill up the room of the displaced water; and immediately the vessel has passed, a wave rushes in from behind, breaking along the beach or dashing against the rocks. I remember once at the time of the Carlist war in Spain (the date I forget), passing in a rapidly moving steamer, where a large body of recruits were assembled on the river bank close by. As the steamer passed, the water rose behind her, rushed up the bank, and dashed over them, thoroughly wetting all, and throwing some over in great confusion. This was, in fact, only a small representation of a sea earthquake wave, such as we heard of in the account of the eruption at Mauna Loa, in May, and again on 17th August, at New Zealand, the shape of the front of which depends, in all cases, on the depth or shallowness of the water.

Mr. Darwin long ago explained the sea earthquake in a similar way.

Mr. Milne (Ed. Ph. Journ., xxxi., p. 269) observes,—That when the sea earthquake wave is studied in examples, it is found that the sea everywhere has *first retired.* The elevation of the sea level has the effect of drawing the adjoining water towards it, thus lowering the level, and for the same reason the advance of the wave must be heralded by depression. This justifies what I have to say about an earthquake on 15th August, 1868, as deduced from the recession of the sea at Lyttelton in New Zealand, the date of our late marine disturbance in New South Wales.

I need not point out that this sea earthquake wave is not what is generally called "*the tidal wave*," though it has something in common with it. Much misunderstanding appears to prevail, as we learn from recent newspaper correspondence, on this point. The "tidal wave," that from which the ordinary tides result, is different in its character from all other waves, inasmuch as *it is not an oscillatory wave.* It results from a lifting action of sun and moon, which raises the particles of water, transfers them to a different locality in advance, and leaves them there permanently at rest, without oscillation or retrogression. The motion is all in one direction, and the transference extends through the whole depth. It has, therefore, been called the great primary wave, or *wave of translation.* The *ordinary* sea waves of the surface oscillate, and their displacements do not reach great depths. They are greatest at the surface and diminish rapidly.

This solitary progressive elevation of the surface of a fluid at rest, is not represented by the sea earthquake wave, inasmuch as the effect produced is by the raising of the sea bottom, and the

impulse is upwards, whilst the motion is propagated in every direction.

These conclusions are derived from a series of lengthened experiments on waves, undertaken by a Committee, consisting of Sir John Robinson, K.H., and Mr. Scott Russell, F.R.S., who had to resolve, among other questions,—1st. The nature of the waves of the sea, and 2nd. Whether the tidal wave is of similar order. Up to 1834, nothing certain was known on the subject, and the true history of the tidal wave dates from 1835.

The great earthquake sea wave, therefore, arises from the earth wave; and is one of two that occur in the ocean during violent shocks; the other called the "*forced sea wave*," being produced by vibration of the sea bottom in contact with the water. In case the shock occurs near a coast, or in shallow water, the "forced wave" will merge in the "great sea wave," or ride on its back; and if the latter takes place in a deep ocean it might not be noticed far out at sea, but would break violently upon any obstacle such as a shallow shore, or other impediment.

The "great sea wave," therefore having arisen from the earth wave, in its propagation, is dependent on the laws that regulate water under such circumstances; but it may be taken as a measure (not true, perhaps, but to some extent, approximative) of the velocity of transmission. Thus, according to Milne, in 1755, the Lisbon shock was transmitted to Madeira in 38 minutes, at the rate of 13 miles per minute, whilst the sea wave reached it at the rate of 3·7 miles per minute. Its rate at Cadiz was nearly the same. The times of the shock at Lisbon and Madeira differed 29 minutes; in 1761, however, the difference was only 6 minutes, the point of disturbance in the latter year being four degrees north of the focus in 1755. The disturbance in 1761 was deeper than that of 1755.

During a severe shock at Lisbon, on 2nd February, 1816, two ships at sea had the earhquake—the one 120 leagues W.S.W. from Lisbon, in *two* minutes; and the other, 270 leagues W.S,W., in six minutes from the time it was felt in Lisbon, which gives the respective rates of 180 and 135 miles per minute.

It is said that the disturbance by the sea wave, during the late Sandwich Island eruption, was transmitted to the coast of California in five hours, nearly 400 miles per hour, and that it affected a continuous coast line of nearly 1000 miles in extent. A similar wave passed from Japan toCalifornia, during the earthquake of 23rd December, 1854, in 12 hours 38 minutes, at the rate of from 355 to 368 miles per hour. By this a Russian frigate was wrecked at Samoda. The sea wave of translation, which was occasioned by the earthquake of Valdivia on 7th November, 1837, made itself felt in the Samoan or Navigator's Islands, a distance of at least 1000 miles more than that from Hawaii to

Sydney. It also reached Hawaii within an hour of the time at Samoa. But in all these cases the wave is propagated without delay. This must have been enormously destructive, for it is stated that a whale ship in 43°.38′ S., near the land, and more than 250 miles to the southward of Valdivia, was so violently shaken as to lose her masts.

Whilst on this branch of the subject I think it right to offer a few remarks on a phenomenon that excited at the time—more recently than the shock of 18th June—the wonder and curiosity of many persons in the colony.

I allude to the extraordinary fluctuations of the tides in the Lower Hunter, in Port Jackson, and along the coast during the 15th, 16th, and 17th, and even up to 18th August, 1868; and along the coasts from Moreton Bay to Hobart Town, Adelaide, and King George's Sound. The particulars as recorded in the daily journals are fresh in remembrance, and as only a few days more than a fortnight have elapsed reference may be given to them at once. But the official remarks of one of our members who is associated with the Observatory may be read here:—

"A remarkable phenomenon is now being recorded by the tide-gauge at Fort Denison, viz.:—At 2.15 a.m. this morning, August 15th, the water in the harbour suddenly began to fall; and in a few minutes rose again. This has been repeated at intervals up to the present time (6h. 30m. p.m.) The fall at each oscillation varies from 1 inch to 22 inches, and the time occupied in fall and rise together from five minutes to forty-five minutes; many of them occur at regular intervals of twenty-five minutes. The most remarkable began at 6h. 55m. a.m.; in seventeen minutes the water fell 22 inches, and in the following fourteen minutes rose 21 inches. The general curve of the tide is preserved, broken only by these remarkable oscillations. Similar oscillations have been recorded by the tide-gauge before, especially during the gale of June, 1867, but never to the same extent. No oscillation can be detected in the barometer."

The rise and fall at Newcastle was even greater than at Sydney —the tide-guage watched by another of our members indicating a rise and fall at low water of 2 feet 4 inches in fifteen minutes, which is about half what was at another hour observed by others among the shipping.

Unusual is this phenomenon, and only once, as we learn by a casual notice, has it been recorded before; but, probably, it escaped detection or passed out of remembrance on other occasions.

Various surmises were offered as to the cause of the occurrence; and, naturally enough, with the recollection of recent earthquakes in mind they come in as the supposed origin. But it was also remembered that there is a *storm wave* as well as an

earthquake sea wave, and the prolongation of phenomena argued more in favour of the former than of the latter. It is within my own knowledge, that long-continued south-westerly winds blowing as they sometimes do for weeks and months, at the chops of the British Channel will heap up the sea in places to 30 feet above its usual level; and I have known more than one instance of Poole Harbour in Dorsetshire (on the shore of which I resided for nearly seven years), which is in fact a vast inland salt water lake, having remained full of water for more than two successive tides, owing to the extraordinary ebb from Portsmouth running in and preventing the Poole ebb from running out. So that such occurrences there can be accounted for.

It was clear that some deep disturbance, whether by earthquake far away to the eastward in the ocean, or an unusually violent Cyclone, produced the late disturbance. The sand mixed with the harbour and river water proved the disturbance to have been deep, so that, whatever the cause, it must have been violent. In fact, it is known by observation and experiment that the sea is affected to unknown depths. Mr. Mallet, who has discussed certain similar occurrences in Europe, gives in no adhesion to earthquakes as the normal original motive power. His words are these—"It seems probable that in the great ocean such vast nodal waves or rollers are frequently produced and propagated to great distances from the regions of storms where they originate, and may simulate many of the phenomena of earthquake great sea waves." (*Report*, 1850, p. 47.)

Again, speaking of other kinds of oscillations, he says, "I am disposed not to attribute such to earthquake shocks at all, but to the sudden slippage under water of large masses of sub-marine bands of sand and mud. . . . . Such a circumstance occurring upon a very moderate scale would be sufficient in a narrow estuary to produce a wave of translation liable to be mistaken for the effect of an earthquake." (*Id.* p. 61.)

These opinions of Mr. Mallet were controverted by Mr. Edmonds in a paper read before the Royal Geological Society of Cornwall, 19th Oct, 1855, and afterwards published in the Edinburgh Philosophical Journal, N. S. (Vol. III. p. 285.) April, 1856. Mr. Edmonds says, the hypothesis was totally inapplicable to facts relating te sea waves and earthquakes in Cornwall and Devonshire in 1755, 1761, 1811, 1843, (July and October) and on 30th May, 1855.

The effects of the passage even of a large and rapid steamer is to produce a wave, which breaking on the shore very often produces effects that seem to a chance observer unaccountable; this I have already spoken of. Now, Dr. A M. Thomson and myself were witnesses to a singular noisy commotion of waves in a secluded harbour on the North Shore, at high water, on the

28th of July, and as no steamer had recently passed, we considered it an anomalous occurrence, without forming any positive conclusion respecting it. But I feel assured it had little to do with a steamer.

I will now quote a few cases of parallel disturbances from Perrey's Earthquake catalogues, where it is expressly stated that no shock was noticed:—

"On the 18th September, 1763, the sea suddenly rose ten feet at Weymouth, in Dorsetshire, and fell back as suddenly.

"On 28th November 1767, the tide at London ebbed and flowed twice in an hour and a half.

"On 6th September, 1785, an extraordinary rising of the sea took place at Rochelle, in France.

"On 11th September, 1787, the Lake of Lugano, in Italy, was violently agitated; there was a violent wind at the time.

"On 4th July 1809, an extraordinary flux and reflux of the sea in the Genoese territory took place, at intervals of a quarter, half, one hour. On the same day a similar fact was recorded near Lisbon, and on the 27th of that month at Naples.

"On 3rd January, 1824, the sea rose and fell unusually at Copenhagen, in Denmark."

It must be admitted, however, that shocks have been recorded as taking place in the neighbourhood of many similar disturbances of the seas and rivers, and of one of them that of Pesaro, in the Pontifical States, on 18th March, 1826, it is said, "the sand, mixed with the water, destroyed its transparency to the distance of two miles from the shore" at Sinagaglia.

The amount of disturbance in August last was so great, and so generally comparatively equal at different places, along a coast line extending through fully 2800 miles, that its source must have been at a considerable depth.

Yet, at first, it was admissible that as the storm and sudden violent gale of the 19th of August followed it, the oscillations might be due to a coming Cyclone; it may illustrate such an effect to quote an example or two.

In the year 1831, a violent swell of this kind broke on the Bermudas, having been produced by a hurricane in Barbados, more than 1000 miles distant. So on 30th January, 1845, the Eurydice frigate was endangered at anchor in St. John's Bay, Antigua, by the swell raised by a storm at Bermuda, quite as far off. Colonel Reid was at Bermuda during the hurricane of 1839, and noted the sea breaking loudly on the south shore, full three days before the storm reached the same locality, and the hurricane was then nearly 700 miles off.

As the storm passed, the south shore became quiet, whilst the north received the impetus of the swell progressing to Newfoundland. This author points out how the muddy appearance

of the water sometimes precedes a storm, owing to the undulations affecting the bottom of the sea; and this was seen at Bermuda in 1831, the day before the hurricane arrived.

The occurrence of meteoric phenomena off the coast of New South Wales on the night of 17-18th August, and the sudden violent south-east gale of the 19th, prove that there was an aerial as well as oceanic disturbance about this period. The death of a steersman in a vessel off Crowdy Head on the 17th, by a meteoric explosion is an extraordinary fact. Respecting such storms there are recorded many coincidences with earthquakes; and such was the case at Tobago, where the violent hurricane of 11th October, 1846, was preceded by a shock. A meteor was observed at Wood's Point, (Victoria) on 20th August, falling during a heavy rain, and succeeded by a shock of earthquake.

All doubt as to the character of our recent marine disturbances, was, however, removed by the arrival of the Kaikoura, from Panama, on the 23rd August, and by her we learn, that the ocean disturbance was felt also on the *east* coast of New Zealand, on the 15th, 16th, and 17th, and that a shock of earthquake was also felt along the east coast and at Nelson and Wellington, on the 17th.

It is certain, therefore, the ocean was affected at the same time, at opposite points, in an area of at least 1,300,000 square miles. This very fact destroys all idea of aerial disturbance having been the motive power, as in that case the motions would not have been *simultaneous*, but progressive. The shock was felt from Lyttelton to Napier; and at the former place a ship lifted on and off the pier, having been first left dry by recession of the water Further particulars will be found in my catalogue.

To return now to the main topic, supposing a shock to originate in the expansion of gases on the surface of a molten fluid, there must in that fluid be a greater velocity than in a vibratory wave of compression in water, which is about 4800 feet per second. On the supposition of a thin flexible crust, a small force might produce considerable effect, but to produce elevation in thick compact strata, a long and continuous force producing tension approaching to dislocation would be required.

In the quotations of time of the shocks already mentioned there may be some error; for no instrument has ever yet been invented to determine such a fact accurately. Moreover, where a shock has to traverse strata of different conditions of structure and flexibility, the times of propagation must vary in each.

I have dwelt long on the mathematical theory, because it is that which appears to have in it the greater elements of certainty, and because we cannot solve the difficulties presented to us without consideration of the laws that regulate motions in solids and fluids, and which belong to what may be called the dynamics and

hydrodynamics of earthquakes. Nevertheless, the observation of facts must be the foundation of our opinions as to the accuracy of theoretical views.

A catalogue of such facts has been made by Mr. Mallet, extending from 1606 B.C. to A.D. 1842, *i. e.*, for 3448 years; and this is continued by Professor Perrey's annual register of earthquakes. The whole of the period up to 1850 has been discussed by Mallet, and in these tables there is much to which the student on earthquake literature may turn with advantage, for what is more trustworthy than the usual gossip about such matters. I find in the catalogues an observation of my own recorded of an earthquake in 1834.

Between 6000 and 7000 earthquakes have thus been brought together, the area being co-extensive with land and ocean; "and nothing," says the compiler, "can be done better in this way till observers shall have agreed to record facts observed on a general plan, and referred to one central focus of collection for discussion, taking advantage, for times of occurrence, of the means offered by telegraphy." These records of distinct earthquakes include numerous shocks at one time, as well as single shocks, and in the case of the 2000 shocks said to have accompanied the late volcanic outbreak of Mouna Loa, in the Sandwich Islands, these 2000 would only be regarded as one. So that the documentary evidence is of greater value than at first appears.

The discussion of so many as 6000 or 7000 odservations, or 10,000 as they are now, has led to some determinate opinions which we must briefly pass in review.

It may be submitted, that if earthquake shocks produce such undulations as Hopkins describes; and if they progress as the Lisbon earthquake of 1755 proves they do, it is most certain that the late shocks could not have come to us from southerly, north-westerly, and north-easterly points at the same moment. They ought, if the undulations were from one focus, to have diverged, not converged. When explained the result is that the direction was the same, from the north-east quarter.

There are some results obtained from the discussion of Perrey's catalogues, that almost startle the mind. This, for instance; that, allowing for the effect of closer observation in the more recent periods, there is yet a presumption that observed earthquakes are and have been gradually increasing in number, and, apparently, in intensity, from the beginning of our era to the present time.

	Earthquakes.
Thus, up to the birth of our Lord, the total number recorded was	58
From that to the end of 9th century, A.D.	197
From 10th to end of 15th	532

From the beginning of 16th to end of 18th	2804
From 1799 to 1850	3240
(Or, in 1850 years, 6773)	6831

Of these, 216 were great earthquakes. The deduction from this is that, at present, we may calculate on one great earthquake destructive of life and property in some part of the world every eight months. (Mallet, Rep. B.A., 1858, p. 56.) and that in the Southern hemisphere the observed earthquakes may be now estimated at one in every two years. Sir Charlas Lyell calculates that the average number of volcanic eruptions is 2000 per century, or 20 per annum, since the ratio for earthquakes, according to Mallet's table, from 1701 to 1850, is 35.310 per annum.

On this is based one proof of the conclusion, that earthquakes and eruptions have a connection. But this is not that of cause and effect. Just now were mentioned great earthquakes. These are arranged in the first class, as destroying multitudes of people and devastating wide areas. 2. Mean earthquakes produce damage of an inferior kind. 3. Minor earthquakes do little harm and occur frequently. The shock of 18th June bordered on the second class, and missed a very little of doing great damage.

The radii of these three kinds of shocks are assumed to be 540, 180, and 60 geopraphical miles.

I have only hitherto selected such facts as throw a general light on the great features of earthquake disturbances; but in order to apply, before I conclude, such as belong to the physical history of this part of the world, it will be necessary to enumerate a few of the deductions which have been derived from the examination of the 6000 or 7000 earthquakes already mentioned.

We are to understand, then, that earthquakes occur in all parts of the earth and ocean, at all seasons and at all hours of day and night. No part of the earth's crust has always, or at any epoch, been more subject than another to shocks; but there is a periodicity in earthquakes, and those countries are most liable to be shaken which are in proximity with the present lines of volcanos.

Tracts not now near volcanos nor centres of extinct action, are subject to frequent shocks, whilst those tracts that are, are not particularly distinguished. Thus, indeed, there are areas in which igneous action action was formerly general, and even now is partially not extinct, in which earthquakes are seldom or ever felt. Such, according to Newbold (Proc. Geol, Soc., Q.J., iv., pp. 336 and 339, 1848), is the case in Egypt, and along the Red Sea; and, according to Mr. St. John, in the Nubian desert, about seventy miles from Syene, whereby there is clear evidence

of extinct volcanos; as well as between Cairo and Suez, and at Aden; besides the hot springs of Tor and the active crater of Gebel Tir.

In general the most violent shocks are not found to take place in regions immediately near volcanic foci, and they have been felt on the ocean where the depth is great, and where no visible phenomena appear on the surface.

The earth wave is a true undulation of the earth's crust, the direction of the shock varying from verticality to horizontality, the motion being direct.

Sounds of various kinds accompany, precede, or follow some shocks, whilst others are not so attended. No sea wave of earthquakes has ever been observed in any earthquake where the centre was inland. But a forced wave may occur when an inland shock plunges into the ocean.

I have chosen these facts from Mr. Mallet, out of many others, all of which he demonstrates by examples, and which are not referred to by Hopkins, in order that, if possible, some ground may be had for the explanation of certain shocks felt in Australia.

And I now add to these two other facts generally admitted, that earthquake shocks frequently follow the bases of mountain chains, and vary in velocity of transmission according to the nature of the geological formations. Thus, in loose beds of clay, gravel and sand, the motion is slowest; in solid rocks the motion is quickest; and in superficial beds over them somewhat less. Known rates have varied from 900 to 6586 feet per second. Results, lower—Mr. Mallet says—than the theory would suggest.

Respecting the effects of elevation of coasts and inland tracts by earthquakes, there is no doubt whatever that such events do take place even in recent times, as they must have occurred in earlier epochs. But caution must be observed in applying this explanation. There is not time now to quote examples, But one source of elevation may be a gradual heating of a solid mass below; and experiments have been made to show the effect of such expansion by heat, and contraction on coasts. And it is on this principle that the difference of level, at different periods, of the temple of Jupiter Serapis, has been satisfactorily explained. It is proved that if the temperature of a mass of sandstone a mile in thickness were raised 200° Fahrenheit, it would expand so as to raise the the rock above it ten feet. And if a mass of the earth's crust of similar description, 50 miles thick, were raised 600° or 800° F., then an elevation might take place of 1000 or 1500 feet. And conversely, cooling would produce depression. Bischoff argues that in passing from a molten to a solid state granite would contract ten per cent. He also says, that if carbonic acid gas percolated silicated alkaline rocks, there would be such an expansion as would affect the volume of altered rocks, producing

mechanical expansion laterally and vertically, thus causing many of the phenomena observed in strata, which hasty conclusions refer to the direct agency of igneous force.

Incidentally, to point out how even the solar heat affects expansion of some of the sandstone in this county of Cumberland, I would refer observers to the coping of bridges, such as that of Parramatta, which is formed of a different rock to the mass of the bridge. The alternate expansion and contraction of the exposed stone causes the cement to be disturbed and gaps to be produced; an effect also observed in houses where careless builders cement with untempered mortar.

It may be further remarked, that the removal of sedimentary matter from one region to another by the ordinary agencies of water, may, by pressure produced in the region to which it is carried, also cause change of level. So that all must not be assigned to earthquake shocks, though the coasts of Chili, and more recently the shores of Cook's Strait, in New Zealand, have been elevated within the last half century by earthquakes.

For the sake of convenience, and to meet a reference made to me by some gentlemen in Sydney, I here introduce a remark or two respecting the Chili earthquake of 19th November, 1822. It is stated by Mrs. Graham, who was on the spot, that the coast was elevated over more than 100,000 square miles, and from 2 to 4 feet. Sir C. Lyell has collected the testimonies in confirmation, and says that from the calculations he has made from the statements of Cruickshanks, Meyen, Freyer, and Darwin, the mass raised must have exceeded in weight 100,000 times that of a mass equal to that of the great pyramid of Egypt, if solid, which would then weigh 6,000,000 tons, and assuming the probable thickness of strata below at only two miles, then the weight would exceed that of 363,000,000 pyramids.

Sir J. Herschel (*Familiar Lectures*, p. 5), says that Aconcagua, one of the Andes, overlooking Valparaiso, nearly 24,000 feet in height, was raised, and that 10,000 square miles of country were upheaved with it. If, however, as is possible, the raised area was at the base of the Andes, then the mountain might not have partaken of the rise ; and it is only right to add that some of the statements made by other observers were called in question by Admiral Belcher, Lieutenant Bowers, and Mr. Cuming, [Their communications may be found in the *Proceedings of the Geological Society*, vol. 2, p. 213-14.] The elevation along Cook's Strait is well ascertained.

I must now briefly refer to the labours of a foreign seismologist, whose work is not considered altogether favourably by Mr. Mallet. I allude to the *Théorie des Volcans* by *Count de Bylandt Palstercamp*, the *Avant propos* of which was privately sent to me in 1833, and reviewed by me in the Magazine of Natural History

in 1834. I will point to some of the diagrams exhibiting his views.

His opinion on elevation is, that eruption of the *feu igné centrale*, the sinking of the crust at the top of its elasticity, and the *éboulement* of strata into great depths, produced by the pressure of water, and the upward interior pressure of the outward crust in the direction of certain radii, generate upheaval, contortion, and tilting of strata.

He explains ocean currents by volcanic action, as corresponding with magnetic aerial motion, and also says, he has discovered a volcanic channel flowing round the globe between two parallels; and that volcanos are like knots on a string, which must partake any shock communicated to either extremity.

Reasoning in this way, he has some speculations on the fact (as he asserts it) that Gillolo, one of the Celebes Islands, the Sandwich Islands, and the Isle de Bourbon, in the Indian Ocean, are seismosically connected.

If this be true, the late eruption in the Sandwich Islanas ought to have some corresponding effects elsewhere, especially in Gillolo, for the accounts of which we must patiently wait. In 1813 a most fearful eruption took place (as in 1673) in Bourbon; the Moluccas did not reply to it; Gillolo alone was shaken; but the Sandwich Islands immediately erupted.

And it appears that when the latter are affected so is the former, as is stated in the Transactions of the Royal Society of London. In the eruption of 1682 and 1683 Bourbon was affected, and 1694 the Sandwich Islands and Bourbon were affected at the same time. Gillolo is considered by De Bylandt as intermediate between the two hemispheres,

I refer to this example to illustrate the views of the author in question, who thus shows, according to his theory, that though the Moluccas are the great source of terrestrial derangement in the Eastern hemisphere; yet Gillolo being sometimes affected independently of the rest, is connected not only with Bourbon and the Sandwich Islands, but with the central source of volcanic action. The West Indies represent the great Western source, corresponding in position with the Moluccas.

Turning now from this brief reference to M. de Bylandt, as belonging to volcanos, I may quite as briefly state his views on earthquakes.

He presumes, that when vibration or oscillation, produced by earthquake shock, takes place, the effect perceived is contradictory to supposed experience. Thus, a vibration felt from north to south really comes from the latter direction. He considers vertical as direct, and horizontal as indirect shocks, to come from the central fire, and that circular or accidental shocks belong to no particular cause. He attributes the first chiefly to

the effects of gases, the results being proportional to the nearness of the disturbing cause to the surface. The *second* class of earthquakes he considers connected with the tumbling in of the covering of immense caverns in the interior crust of the earth; the *third* class he assigns to electricity in the earth and atmosphere, seeking to establish an equilibrium.

He gives a mathematical determination, illustrated by a diagram, showing that earthquakes are to each other inversely as the squares of distance from the point of disturbance. (*Tome* I, p. 388.)

In summing up, he considers earthquakes to be precursors of volcanic eruptions, and states certain conditions of the air and sea, remarking on the extraordinary and unusual sensations of men and other animals. Some of his conclusions are confirmed or adopted by Mallet, and are also given by other writers.

But Mallet, gives a further useful rule, by which we may judge of the class of earthquakes. Thus the radius of a great one is considered to be 9°, or 540 miles; of the next class, 3°, or 180 miles; and of the third, 1°, or 60 miles geographical. This would again place the earthquake of 18th June in the second class, or intermediate with Nos. 2 and 3.

It cannot be supposed that the preceding discussion has exhausted all the topics connected with the subject. Yet, it is perhaps, almost too much extended for time to make the application proposed to be made of it. It has, however, appeared to me advisable to present the deductions of different authorities, in order to make some explanation possible.

I have only to regret that, in entering upon an attempt of the kind, we have so few local data. Yet, in dealing with one part of the subject,—viz., whether there is any change going on in this part of the world from earthquakes, we must not neglect two important considerations, viz., that the Pacific contains both a subsiding and a rising area, as shown by the researches of Darwin and Dana, and that (so far, at least, as we can discover) there is evidence over large areas, in the present epoch, of one of rest; whilst on some parts of the shores of Eastern Australia there are, notwithstanding, evidences of elevation, which is also the case in New Zealand, as emphatically proved by the earthquakes of 1855. Our late shock was probably one of depression.

We must also bear in mind that, generally speaking, as shown by Mallet, the result of all earthquakes is not the production of *permanent elevation*, and that they generally indicate final *subsidence instead*. But permanent elevation may *accompany* them, produced by other and connected causes, as shown by Hopkins, either the great elevatory forces within the earth, or secondary operations belonging to them.

An earthquake, then, may be held as the *result* of *elevation*, but *not as the cause.*

Now, without regarding with too much favour the conclusions of Count de Bylandt Palstercamp, who asserts that in one instance eruptions took place on the opposite extremes of the earth's diameter at the same moment (implying, in his opinion, a source in the very centre of the globe, or that there have been earthquakes that have traversed in a right line thousands of miles), we have facts on record which prove to us that vast areas may be simultaneously, or continuously, affected by one eruption or shock.

Thus in A.D. 860 all Europe was shaken at once; and on 1st November, 1755, when Lisbon was destroyed and 60,000 persons perished in a few minutes, though the shock was only felt very slightly in Oporto, yet it was felt over a surface four times greater than all Europe—in the Alps, in Sweden, in the West Indies, in the north of Africa, and in Canada; and in April, 1815, the island of Sumbawa, in the Malayan Archipelago (to the north-west of Australia), was affected by the eruption of Tomboro mountain, the sound having been conveyed through the earth to Sumatra 970 geographical miles in a straight line, and to Ternate 720 miles off. Ashes or triturated materials from the eruption fell in Java 300 miles off, and finer portions fell in Amboyna and Banda 800 miles east of the crater. Thus the whole of the Moluccas, Sumatra, Java, Celebes and Borneo were alike affected.

If there had been any persons in Australia who could have recorded it, it is very probable that the north-west part of this continent, to upwards of 300 miles inland, might have been added to that area.

But when it is asked, as it has been by some, whether the earthquake felt here on 18th June last was connected with the great eruption of Mouna Loa in the Sandwich Isles, it must be stated that it is very highly improbable; for the two localities are nearly 4200 miles apart on different sides of the Equator, and if any reliance is to be placed on Palstercamp's theory, out of the line of connection.

But, though the sea wave broke on the shores of California no indication of the kind was exhibited here, or could have taken, place within a few hours. And it is impossible to connect shocks of earthquake after so long an interval as more than two months.

Yet I must not omit to remark that, in a letter received by me in July, a distinguished geological friend in New Zealand states, from experience of shocks in that country, that ours nearly amounted to a dangerous earthquake, and that those who are familiar with such matters prophesied that the terrestrial disturbance was progressing westwards, and had possibly passed New Zealand.

That it was a severe shock I am willing to admit; but we must wait awhile before we can speculate upon its connection with any

distant locality. It will probably be found that its focus was under the ocean, not many miles to the eastward of the mouth of the Hunter.

Looking at the condition of Australia, so far as is known, and to the history of such shocks as have been before recorded, we are, I hope, at present, as physically considered, in no fear of any such great convulsion as has often overthrown cities and desolated vast regions in a few moments; and yet when we read the records of such disasters as have been chronicled, we have no right to presume that this country may never be so affected.

Although in New South Wales, Queensland, and Western Australia, so far as we know, there is not any authenticated fact of even an *extinct* volcano (for the often puffed performances of Mount Wingen are nothing but the effects of burning coal seams), yet in Victoria and a part of South Australia there are numerous extinct craters which up to the present epoch have erupted, whilst the north and north-east coasts are belted by islands, which, as in New Guinea, the New Hebrides, and New Zealand, contain active craters or boiling springs; but these are at least 1000 miles distant.

In more ancient geological epochs, earthquakes and eruptions must have been wonderfully active even here. The flow of basaltic lava, basalt, trachyte, and greenstone and other igneous rocks, now exhibited as intrusive or bedded or overflowing masses, must have worked great changes in the strata then affected, and though no distinct foci of eruption can now be distinctly perceived, yet such there must have been, only obscured now by subsequent processes of geological change.

In this way noticing the numerous points of such outbreaks, we come to see how in pre-historic and ancient geological times, Australia, as an Archipelago, was distinguished by eruptions subaerial in part, as well as submarine, though not of the identical character of some of those which are numerous in the Pacific Islands and the Malayan Archipelago.

Considering the briefness of the period (only eighty years) since New South Wales was first occupied by civilised men, and the real ignorance or indifference of many of its first occupants, as well as the gradual way in which exploration has extended, it is not strange that we have but few early recorded examples of earthquake shocks.

The few, however, that have been rescued from oblivion, are sufficient to justify the belief that numerous others have passed unrecorded; though my own conviction is, that I have myself felt several, of which no other memorial remains than my own solitary memoranda.

It may be well, first of all, to enumerate such as are undoubted occurrences of the kind, and arrange them in a tabular form. I

premise, however, that I include indications of probable shocks in some instances, of which I will give explanations in due order.

But it may be useful first to explain that I so include them according to the known peculiarities of earthquake shocks, which may embrace three separate—though connected kinds of wave: 1. The earth wave; 2. the earthquake sea wave; 3. The sound waves through the earth, the sea, or the air.

This is well explained by Mr. Mallet in the "Admiralty Manual," (p. 206). He says, "If one stand upon a line of railway, near the rail, and a heavy blow be delivered at a few hundred feet distant upon the iron rail, he will almost instantly hear the wave through the iron rail; directly after he will feel another wave through the ground on which he stands, and lastly he will hear another through the air; and if there were a deep side drain to the railway, a person immersed in the water would hear a wave of sound through it, the rate of which would be different from any of the others—all these starting from the same point at the same moment."

It is very certain, therefore, that where a vibrition may be too weak to be sensibly felt by an inattentive person, yet the sound may be audibly felt; and this, I think, has very often happened in the interior of this country.

I now proceed to refer to a Catalogue of all the Earthquakes in Australasia of which I have obtained particulars, but which at present is not in a state for publication. For the present I must be content to offer a few remarks on some of the New South Wales shocks enumerated in the Catalogue, in order to compare the phenomena reported with those observed during earthquakes in other countries, and to obtain, if possible, some additional idea of the class of earthquakes to which those felt here probably belong.

Although I have headed my list with Captain Furneaux's New Zealand shock, in 1773, yet the first recorded shock in New South Wales was felt within a month of the foundation of this colony. It is an interesting commencement to our Catalogue.

The duration of the disturbance agrees with that of the shocks felt in 1837 and 1868.

Respecting the noise,mentioned, "like that of a cannon," this too is in agreement with the noise heard also during the two later occurrences.

Mr. Kempson, who is my authority for the shock of 28th April, 1868, records the same kind of noise. He says it was "like the firing of ordnance." Collins's remark has just been quoted. The Rev. C. P. N. Wilton says, on 3rd August, 1837 the noise was "like the distant discharge of artillery." This kind of noise I consider of great importance in the identification of a probable earthquake when other data cannot be obtained. For it must

naturally be suggested that in the far interior there is no likelihood of any sound occurring of actual artillery or cannon.

The application of this argument will be made further on. It is advisable, however, to show by examples quoted from the published catalogues of the 6000 or 7000 earthquakes before mentioned and from other sources, the high probability of the fact assumed.

At Glaris, in Switzerland, 7th May, 1682, a report like that of a large piece of ordnance was heard. On 24th March, 1697, when Acapulco, in Mexico, was destroyed, the shocks were "accompanied by a loud noise like the firing of cannon." In the Canton of Glaris, in Switzerland, 10th February, 1703, half-an-hour before, "a great noise was heard in the air." At Eglisau, on the Rhine, 3rd August, 1725, the shocks were preceded by "a loud noise like the discharge of a piece of ordnance." On 1st September, 1726, at Palermo, "a loud noise was heard in the air." On 12th December, 1751, at St. Domingo, "noises like the explosion of cannon were heard." And on 9th March, 1753, in the mountains of Piedmont, Switzerland, and Savoie, the same noise as of cannon was also heard.

In January, 1757, during an earthquake at Lisbon, an explosion like that of a cannon is reported in the *Gazette de France* as having preceded it. Again, on 7th March, 1756, at Odivillas, near Lisbon, the shock was accompanied by a noise "like the report of a cannon, repeated many times by an echo." So, on 1st September, 1763, in the Moluccas, "a subterranean noise was heard like the firing of cannon." (An. Reg. vi., 96).

On 5th October, 1784, at the Fortress of Rheinfels, on the Rhine, the shock felt was "accompanied by a loud explosion like the report of a cannon."

A great earthquake on 6th April, 1790, over a considerable part of Turkey, was "accompanied by a noise like the discharge of a thousand muskets."

The Lisbon earthquake of 27th November, 1791, ended with an "explosion like the report of a cannon." Persons drawing water from a well at Cumana, in South America, on 4th November, 1799, heard a noise "like an explosion of gunpowder." In the Ural on 28th July, 1800, shocks were each time preceded by an "explosion like that of a six-pounder, the noise lasting more than two seconds."

On 7th August, 1802, during shocks at Cahors, in France, a loud explosive noise was heard, and for 40 leagues round a similar occurrence happened at Vitré (Ille et Vilaine), on 11th February, 1805.

On 26th July the same year, a double explosion "as of cannon was heard" from Vesuvius during the great earthquake of Calabria. On 26th December, same year, a "loud explosive noise"

was heard during a vibratory shock at Bulke, near Hanover. "Noises like the explosion of cannon were heard" at Barga, in Piedmont, during the earthquakes at Pignerol, on 8th April, 1808.

"Three loud explosions" were heard at La Tour, on 9th May, 1808, and one on 14th of that month at the same place.

At Angouléme, on 22nd August, 1817, a "loud detonation" was heard at the termination of shocks. Similar "detonations" preceded a shock at Motz, in Savoie, on 17th May, 1818. "A noise like that of a distant cannonade" accompanied the shocks felt at Aix la Chapelle, 4th and 5th November, 1818. At St. Andrew's, in Lower Canada, on 15th July, 1819, a shock was attended by "noise like the firing of cannon." The shock at Barmouth, in Merionethshire, on 27th September, 1820, was "accompanied by a noise like that of cannon." "A loud explosion" followed two severe shocks at Cherbourg on 16th June, 1822; and "two loud reports" accompanied the violent shock at Comrie, in Perthshire, on 13th April of that year. At Ancona, on the 10th June, that year, "a loud explosive noise" was heard, accompanying a shock. The earthquake at Karlstadt, in Sweden, on 10th September that year, was "preceded by a noise like that of a cannon." A noise "like that of a cannonade" attended the shocks in Ceylon on 9th February, 1823. "Detonations" were heard in Meleda isle, in the Adriatic, from 1822 to 1823 at different times from March to November, and repeated in February, 1825, accompanied by slight shocks. At Valentia, in Spain, a noise "like that of a cannon," accompanied a very severe shock; and in New Brunswick, in North America, a severe shock was "accompanied by an explosion like that of a piece of ordnance," on 9th July, 1824. In Cuba, on 19th August, 1826, three heavy shocks "ended with an explosion as of a large number of heavy pieces of artillery." At Ripon, in Yorkshire, on 9th February, 1827, "a tremendous explosion was heard" during heavy shocks. "Loud explosions were heard on 8th July, that year, at Petropaulovski, in Kamschatka, during shocks which attended the eruption of Urvatschimskaju, "violent detonations" following the widely extended earthquake from S.E. to N.W. In Columbia, in South America, on 16th November, 1827, they occurred at "intervals of 30 seconds, with wonderful regularity."

As these shocks occurred at 6 a.m., and as similar shocks took place at Ockotzh in Eastern Siberia, at 9 next morning, which was exactly the same time (allowing for longitude) it is believed these shocks were the same, propagated through "the enormous distance from Santa Fé. It is upwards of 8000 geographical miles.

In Suabia on 29th January, 1828, during a smart shock a heavy noise "like a distant cannonade" was heard, and on 2nd Feb-

ruary "three loud explosions" from below were heard along the coast of Naples, during a most violent earthquake, Vesuvius only smoking, the sea calm, and great damage done.

At Ancona, in the Papal States, on 22nd March, 1829, "noise like the firing of artillery" was heard during two severe shocks.

Similar explosions, seemingly high in the air to the south, quite unlike thunder, are recorded of the severe shock felt at La Rochelle, in France, on 27th November, 1829. "Dull explosions were heard in the air," and terrible portents are mentioned of the earthquake in China on 26th June, 1830. "A loud explosion, as a fire of heavy ordnance," followed a shock at Coblentz, on the Rhine, on 28th December that year; and "an explosion like that of a cannon" followed the destructive earthquake in Calabria on 8th March, 1832. At Katmandu, in Nepaul on 26th July, 1833, a frightful earthquake was "attended by a noise compared to that of a hundred pieces of artillery." "Loud explosive noises were heard at Volterra, in Tuscany, 15th to 17th April, 1834. At Chichester, on 27th August, 1834, during a shock (which I well remember to have occurred), a man on the shore heard a loud report of a great gun, and immediately felt the ground shaking under his feet." Explosions or detonations also accompanied shocks at Keni, in Bessarabia, on 6th May, 1834; and at Porsgrund, in Norway, 3rd September, 1834; at Borgataro, in Tuscany, on 8th March, 20th April, and 25th April, 1835; at Palma, in Majorca, 16th and 17th June, 1835; at Simegh, in Hungary, 9th February, 1836; at Venice, 21st June, 1863; at Nismes, 16th September, 1836; and at Vizille, in France, on 29th January, 1837, a violent explosion like the simultaneous discharge of several pieces of artillery preceded some considerable shocks. A noise like the report of a cannon accompanied two slight shocks at Meleda, in the Adriatic, on 7th June, 1838; and singularly enough in the same place, on 7th June, 1839; the former coming from W. to E., and the latter from S. to N.

On the 10th September, 1839, a loud explosion followed a severe shock in Monmouthshire; and on 21st October, 1839, the noise was compared to that of artillery, and other similar sounds, when two-thirds of Scotland were shaken. During the Comrie shocks of that time the noise was heard in the air, while the earth was not sensibly in motion. Mr. Stewart says the noise heard by him on the 23rd October of that year, at Ardvoirlich, seven miles west of Comrie, could be compared to "nothing more nearly than the report of one of the heavy guns of Edinburgh Castle, as heard in the New Town when fired on the south side of the Castle." He says the "sound proceeded from the atmosphere, and not from the ground." At Hamilton, in Upper Canada, on 10th September, 1840, loud subterraneous explosions;

and at Roquemaure, in Languedoc, on 2nd September, similar explosions attended shocks.

At Oban, in Argyleshire, "the watcher heard a noise like that of a cannon discharged at a short distance," at a bottom of a lighthouse where the vibrations were not felt, though the lighthouse rocked.

At Tiflis, in Georgia, two loud explosions accompanied a very severe vibratory shock, on 20th May, 1841.

On 15th July, 1841, in Denmark, the air vibrated during shocks, as during "a discharge of artillery;" and a loud aerial noise attended the tremor at Sparta, in Greece, on 12th June, 1842. Two explosions also accompanied a shock at Nantes, on 13th November, 1842.

Lastly, to show the connection between such shocks and volcanic eruptions, I quote Mr. Campbell (*Frost and Fire* II. 374.), who, in a letter dated 10th February, 1865, from Giarra, during an eruption of Etna, thus writes:—"At the present moment, while I am writing, all the windows of the house I am living in have been broken by concussion, which was accompanied by an earthquake. The noise is like a continued cannonading, with a discharge from time to time of a hundred guns." Numerous examples might be also quoted from eruptions of Vesuvius, and in the Andes.

These examples have been quoted from all available sources, not only to confirm the reports of three of our earthquakes, but to justify my belief that there have occurred (of which there is no other evidence than such aerial noises) six other shocks, though the observers have left no other phenomena on record. The bare mention of the facts would only attract the passing attention of the reader; but viewed in connection with the preceding remarks, I think I am justified in assuming that shocks of earthquake took place at the times mentioned.

One of these must have occurred between 27th August and 3rd September, 1845, and is thus referred to by Captain Sturt (Central Australia. II. 25):—

"When Mr. Browne and I were on our recent journey to the North, after having crossed the Stony Desert, being then between it and Eyre's Creek, about 9 o'clock in the morning, we distinctly heard a report as of a great gun discharged to the westward, at the distance of half a mile.

"On the following morning, nearly at the same hour, we again heard the sound; but it now came from a greater distance, and, consequently, was not so clear. When I was on the Darling, in latitude 30°, 1828, I was roused from my work by a similar report; but neither on that occasion nor on this, could I solve the mystery in which it was involved."

Sir Thomas L. Mitchell heard a similar report on the Darling.

On 24th May, 1861, Wills and King heard a like explosion on Cooper's Creek; and lastly, Mr. Landsborough, on 18th May, 1862, heard a similar report on the South Warrego, which he thought was that of a gun, but it is very doubtful.

The similarity of these noises to that of an aerial explosion, like that of a cannon, might well attract notice at the time, and when we find in the examples quoted that such explosions have been heard at a distance from the locale of a shock, sometimes preceding, sometimes following it, we may safely presume that the noise was not of a falling tree (and in some of these six instances recorded by our explorers, there was scarcely any probability of such a solution), and therefore I include them in my list of shocks. And let me remark, that they all occurred in the same kind of country, and in the same geographical region. I should be very glad to receive fresh data for the establishment of these occurrences as indicating earthquakes; and from Mr. Kempson's letter (already named), it would appear that the flat interior is subject to them.

With respect to the singular fact pointed out by Mr. Wilton, that the shock at Newcastle, in 1837, was felt strongly on the beacon cliff, but not felt in the coal mines, twenty-three fathoms below the surface, this is paralleled by some curious instances in Australia.

During the eighty shocks of earthquakes which were felt at Maestricht, in Belgium, from February to April, 1756, the shocks in general "were stronger in the upper parts of the houses than on the pavement." During the same period, a great part of England, France, and Germany was shaken; and "in the coal pits near Liége, the miners, at the depth of 900 feet, heard a rumbling noise over their heads (and then felt the shock), whilst those above ground heard a similar noise under their feet."

Professor Perrey calls the attention of physicists to the circumstance, that in the silver mines of Marienberg, in Saxony, at the beginning of this century, powerful shocks alarmed the miners so that they ascended to the surface, where no shock was felt at all. D'Archiac, who quotes this case (Histoire des Progrès, Tom. I., p. 609), takes another from the Cosmos of Humboldt (I. 529) of an inverse kind, in the year 1823, when the miners of Fahlun and Persberg felt no shock, whilst over their heads a violent earthquake greatly alarmed the inhabitants.

This is precisely what Mr. Wilton mentions, and which was the case also at Newcastle on the 18th June last, where a number of labourers who were working on the wharf "declare they felt nothing of the shock whatever." It may be said they were so occupied as not to distinguish the motion.

In California, on the 29th May this year, miners underground felt the shock that occurred at Virginia City very plainly, with

"a terrible rumbling as if the roof of the works had fallen in;" and, from the accounts I have read, the shaking above ground was severer still.

It can hardly be doubted that some of the above examples belong to M. de Bylandt's third class of earthquakes, as in some way connected with electric and other adventitious forces, a conclusion I would also admit in relation to our shock of the 18th June, as experienced on the Hunter River.

Respecting the shock of 1809, felt at Prospect, Mr. Lawson remarked to me, that it changed the well waters from fresh to salt. This may merely refer to a local circumstance, the whole of the soil in the formation on which his house stood being naturally saline, and the effect of draining off the fresh water might be to allow the saline springs to operate.

If the subject deserves further consideration, the enquirer may be referred to examples of mineral changes produced in springs by earthquakes, as recorded in Perrey's catalogues, and in the valuable Report of Dr. Daubeny "on Mineral and Thermal waters," wherein he not only alludes to the influences of earthquakes, but to the effects produced on water by mineral properties of soils.

He also alludes to the possibility, that salt may be formed (as in certain strata) by volcanic action. (Report B.A. 1836), and during the earthquakes of 26th December, 1755, in the Alps of Europe, some of the wells there became salt.

I would now offer a few remarks on the shocks recorded by myself at Parramatta in 1841, and at St. Leonards in 1868.

Respecting the direction and time of the former I have no doubt. At the moment of its occurrence I was in bed, being unwell, and had my face turned towards the clock on the church, facing to and not far from the window, wishing to know the time. The other observers, with one exception, mark the time as 8 o'clock. But Mr. Mackinlay, of William's River, states that he felt the shock there at a quarter-past 7. If *his* time was correct there must have been two shocks that morning. Moreover, he states that the motion lasted from ten to fifteen seconds, whereas the motion was felt by myself during not more than five seconds.

The direction was a little east of north, determined in a way that could not deceive, by an observation on the soap-suds thrown up in the hand-basin in the room, and which is the next best indication to that of treacle. In that instance the shock came from the direction of Maitland, and Mr. Dunlop, the late Astronomer, who at first ridiculed the idea of my turning a basin into a seismometer, afterwards, when he had returned from a visit to the Sugarloaf, near Maitland, apologised for what he had said, and acknowledged himself satisfied that I was right. Some

weeks after, news arrived that at the time of the shock, White Island, north of New Zealand, was in eruption.

The shock of 18th June, 1868, I recorded in the *Herald* as occurring at about fifteen seconds before midnight, by my watch, which was at my side, as I was reading. At gun time that day, the watch was just 15 seconds too slow. Consequently, I consider it occurred exactly at midnight. This agrees very nearly with the Windsor observations, allowing for longitude. On feeling the shock I took the bearing by compass of the point at which the shock entered my room. My son was at the time writing in a lower room, and on the same line of bearing indicated by me above, one window of three in the room, was so violently shaken that he rushed out to see whether some one was trying to enter the house.

The direction in this case was nearly the same as that in 1841, and taking into account the agitation of the sea and all the circumstances as well as the great extent, more than 40,000 square miles affected, there can be no doubt, that it was a shock propagated, from the north and east, and we may perhaps, hear something of a contemporaneous eruption in that direction.

It may be well to add, that this concurrence of direction in the shocks of 1841 and 1868 is quite in accordance with the deduction from the 7000 earthquakes enumerated by Perrey and Mallet, the latter of whom points out in one of his reports that in places subject to frequent earthquakes, "they generally come to one and the same place from the same point of the compass." (*Report*, *B.A.*, 1850, p. 18.)

It is stated that the shock at Windsor was felt from the south, and, as correspondents writes to me, at Newcastle from the north-west, and at Raymond Terrace from the south, it is quite impossible to reconcile these different points of local disturbance with any single source, and if these observations be correct, there must have been more than one shock. But, notwithstanding these inferences, it is very clear that the shock at Raymond Terrace must have come from the N.E., for the blow was felt at the south corner of the house, (*i. e.*, from S.W.) as it passed away. The north-east wall of Mr. Bolding's house appeared to be falling *outwards*, a result of the undulations, which as pointed out by Lyell (Principles II. 138) cause buildings to fall generally backwards rather than forwards, *i. e.*, contrary to the direction of the earth wave. I am informed, a shock was felt earlier in the evening at Maitland, and one still earlier in Port Jackson, and another on the Murrumbidgee. And if the notices inserted in the Victorian papers relating to a singular and long continued noise heard at Beaufort on the 5th July and vibrations at Geelong on the 24th, be correct, coupling them with the noises at Lake George on 10th and 11th

July, as reported to me by the Astronomer, and at Nundle on the 30th July, then we may rightly conclude that the agitation was more prolonged than was at first supposed.

I have carefully compared all the published and many private statements, and I find that the average results give from three to five vibrations, lasting from two to four seconds; for we must reject some, which make the vibrations last a minute and more, arising from the difficulty to persons aroused from sleep of ascertaining time accurately. The noises heard are variously described; but that heard by myself is mentioned by several observers at a great distance, and one mentions the noise as of artillery firing; others refer it to that of waggons, omnibuses or railway carriages; but the *heavy blast*, sudden stoppage of motion, a charge as of cavalry, a heavy blow upon the roof, &c., show that there was an explosion, independent of the low rumbling sound heard by others. One observer speaks of a metallic clanging sound upon the metal roof of his house. "A brazen sound (*æneus clangor*)" is spoken by Cornelius Gemma, on 31st March, 1554, during a violent shock in Belgium."

Mr. Bolding, of Raymond Terrace, has given me a valuable account of the noises and other phenomena experienced by him, and of a singular clapping in the air. The time was variously assigned, but the average is midnight. It is impossible that at Minmi (as stated) it could be at a few minutes after 12 o'clock, when (as is also stated) it was at 5 minutes before at Wallsend. The direction is given variously from E. to W., N.E. to S.W., N.W. to S.E., N. to S., and from S. to N. But the greater number make it as I have assumed it to have been from direct observation, from N.E. or a little E. of it towards S.W. the motions at right angles to this direction being the transverse effects. Unquestionably it was felt more violently about the lower Hunter than elsewhere, and the heaving of the earth was distinctly perceived at Newcastle and Raymond Terrace. The swinging of the lamp noticed at Townhead, near Singleton, is paralleled by the swinging of chandeliers in churches at Amsterdam, during the Lisbon earthquake of 31st March, 1761, and in a church at Rotterdam during a shock at the end of January, 1804.

It is stated that no effect was produced on 18th June, on the instruments at the Sydney Observatory.

But this is of no importance, as during the great earthquake that shook all central France on 5th July, 1841, it is distinctly mentioned, "no effect of any note was produced on the instruments of the Observatory at Paris," whilst in the department of the Indre, "a clock which had been stopped in February, 1840, and had been left so, was again set in motion by that earthquake, and struck the hours"—a fact also stated in the report

from East Maitland respecting a clock "which had not gone for months, and could not be coaxed or forced to go, but since midnight last night," (says the *Evening Mail* of 19th June) "the pendulum has continued to oscillate, and the clock is apparently as reliable a time-teller as in its most palmy days."

Again, the stopping of the school clock at Morpeth is what occurred at Lisbon on the 5th April, 1772, when, during some violent shocks, several pendulums stopped. This also was the case at the Observatory in Cadiz, in Spain, on the 12th April, 1773, and again at St. Malo, in France, on the 15th of the same month. Several clocks also stopped at Boppart, on the Rhine, on the evening before the severe shock of 26th February 1780, probably from an otherwise unnoticed shock at the time. On 23rd April, 1868, during a sharp shock at San Francisco, Mr. Milner's astronomical clock, and the Bank, Post Office and other clocks stopped at the same instant, viz., 3h. 54m. p.m. It lasted 30 seconds, with tremulous motion, (*Californian Paper*, 25th April.) It is moreover stated that the shock felt at Virginia, in California, on the 29th May 1868, stopped the great 300 horse-power steam engine in work at the mines, and that it was with difficulty again started.

On these pendulums I would remark, that as they could only have stopped because they vibrated in the plane of the shock, the direction as well as the time is indicated by the stoppage; and beyond this, observations of the kind are of no especial value, because it does not require an earthquake to derange or regulate a clock.

Notwithstanding this, the coincidences of the facts noticed with similar facts in Europe long ago are interesting and suggestive. They serve to point out that no fact observed during an earthquake, however apparently unimportant, is without a relative value. Even the alarm exhibited by cattle, dogs, poultry, as well as by man, is a useful incident, as proving the occurrence of some invisible influence which marks the intensity of a shock. It is not necessary to say that in numerous earthquakes of old date in other parts of the world, the same effects, in that respect, were noticed as during the earthquake of 18th June.

Nor is the occurrence of meteors, as at Maitland, an unusual one. On 6th December, 1674, two igneous meteors or balls of fire fell shortly after the great Switzerland earthquake. At Perth, in Scotland, on January 2nd, 1756, as well as in the west of Ireland, and at Berne, Brieg, and other places in Switzerland, on the 3rd and 5th May of same year, meteors were seen during the shocks that then occurred. A brilliant meteor also followed the shocks at Salonica, in Turkey, on 14th August, 1760; and on 13th January, 1763, luminous meteors attended the shocks at Nordland, in Sweden. At Coruna, in Spain, on 21st October,

1766; and at Charlestown, in South Carolina, on 24th November of the same year, a meteor attended each of the shocks.

On 8th March, 1832, during a destructive earthquake in Calabria, a meteor was observed at Potenza, lasting nearly a minute, and followed by an explosion like those previously noticed.

Lastly, at Wood's End, in Victoria, on 20th August, 1868, a meteor was observed to fall during a storm, and a minute afterwards a shock of earthquake was felt.

Humboldt mentions a shower of meteors before the Mexican shocks of Quito, on 4th February, 1797; and on 11th November, 1799, at the time of the Caraccas earthquake, but these belong to a totally different origin, though they are quoted as coincidences; nevertheless we have yet to learn whether independent of any ordinary meteoric connection, the great cosmical displays of November may have some, at present, undiscovered influence on derangements of the earth's organism.

The following years are mentioned by Mallet as having witnessed the occurrence of meteors contemporaneously with earthquakes:—B.C. 95; A.D. 893, 1001, 1325, 1640, 1683, 1703, 1737, 1752, 1810, 1820, 1822, 1828, 1829, 1831, 1833, 1835.

It is time to draw this discussion to a close. But I have been anxious to submit all the occurrences recorded of our late earthquake to a careful revision; and I think we may allow that it was a shock of considerable intensity, accompanied by meteoric phenomena.

On this occasion it would be impossible to examine the facts relating to previous earthquakes in the other colonies. Should data be obtained for such a purpose, I may, perhaps, be hereafter enabled to resume the subject; and I would here take the opportunity of soliciting from persons who are able to do so, that they would kindly commnnicate to me references or details respecting such instances as have not yet been recorded.

I am quite satisfied that shocks are far more numerous in Australasia than many persons imagine; and if the deduction of Mallet is true, we have a right to expect them to increase in number; nay, I felt a shock in the month of April this year, as before mentioned.

The social and moral features of this topic are foreign to the mere question of scientific discussion, but we must not shut our eyes to two considerations which bear on those feelings and sentiments which belong to man in relation to the Creator.

After all the researches that have been made, and after a careful analysis of more than 10,000 observations, no cause of earthquakes, free from doubt, or sufficiently precise, has been arrived at. This, therefore, should induce a closer investigation than has yet taken place. It may at last be found, that it is a mystery

far deeper than we can understand; and we may with all our study be compelled to leave the absolute knowledge of it till we shall have passed the "*flammantia mœnia mundi.*" We have, however, reason to believe, that earthquakes, and, of course, volcanic action are necessary means for the support of the world in a state of equilibriun, and for the maintenance of the creatures that inhabit it. With all their horrors, they are part and parcel of the contrivances by which this earth maintains its inhabitants and fulfils the promise made to our race, that "*while the earth remaineth*, seed time and harvest, and cold and heat, and summer and winter, and day and night shall not cease." On the other hand, there are circumstances which array this subject with a magnificence that the most cold-blooded philosopher cannot but appreciate.

Without stepping aside to divert our thoughts into another channel, we must not forget that the history of earthquakes is full of the gravest and most exciting of all reflections. We have the authority of sacred and profane records for the evidence of the truth, that if the Creator has designed derangements in the earth's organism for the carrying out of his merciful designs for the advantage of man, so has He in store means in them for calamities, trouble, and alarm, the times of which (as we are convinced by the failure of our efforts to solve the difficulties presented to us) are in His own hands.

If geologists are now full of speculations as to the entombed relics of ancient generations of creatures sepulchred in the solid masses of the earth's crust, what might not (as has often been said) be their deductions could they reach the confused heaps of men and animals buried in the sea, or sunk into the depths of the earth suddenly opened for them! Thousands—tens of thousands, hundreds of thousands—of human beings have perished by earthquakes. And "if," to use the words of a careful investigator of the scientific part of the subject, "we suppose but one great earthquake in three years over the whole earth, and that this involves the entombment of only 10,000 human beings; and that such has been the economy of our system for the last 4000 years, then we shall have a number representing above 13,000,000 of men thus suddenly swallowed up, with countless animals of every lower class. Sir Charles Lyell then with good reason suggests, that even in our own day we may yet find remains of men and of their habitations and implements, thus buried deep and embalmed, as it were, by earthquakes that occurred in the days of Moses and the Ptolemies." "Large, however, as thus would seem to be the gross effects of earthquake action upon the organic world, they are, probably, insignificant in comparison with the aggregate entombment of even man alone, due to the everyday progress of accidental events; and shipwrecks alone will

probably disclose a vaster mortality, 'when the sea shall give up her dead,' than all that have perished by earthquake and its effects." (*Report, B.A.*, 1850, p. 63.)

There is, however, one consideration which ought not to be forgotten—that however man may be affected by these accidental events, as this writer calls them, the earthquake "will ever maintain its supremacy over all phenomena and circumstances, for it is out of the power of man to foresee, to provide for, or to counteract its effects;"—and if nothing else can teach the same lesson, he may therein be able to see his utter powerlessness and insignificance amidst the wonders of that creation in which he holds dominion over all the other works of the Creator.

As Humboldt has well said, we may flee from the crater of a volcano in eruption; or even from a lava stream that threatens to invade our dwelling; but "in an earthquake, direct our flight whithersoever we will, we still feel we tread upon the very focus of destruction." We lose our faith in the idea of stability and practically acknowledge that no figurative language can convey so grand a notion of the glorious majesty of God, as that which an ancient prophet uses in describing the terrors of man, "when He ariseth to shake terribly the earth."

ART. V.—*On the Water Supply of Sydney, by Professor Smith.*

[Read 14th October, 1868.]

IT is my intention to give in this paper a brief account of the manner in which Sydney has hitherto been supplied with water, reserving for some future occasion the question of the improvement and extension of the supply.

The first fleet sent out from Great Britain to found the colony of New South Wales, arrived, as you may be aware, in Botany Bay on the 18th, 19th, and 20th January, 1788. Being disappointed with the capabilities of that locality, "which," says Mr. White, the surgeon-general of the expedition, "does not in my opinion by any means merit the commendations bestowed on it by the much-lamented Cook, and others whose names and judgment are no less admired and esteemed," the Governor (Phillip) and a small party went round to ascertain if nothing better could be found in Port Jackson. "The different coves of this harbour," we are told in 'Phillip's Voyage to Botany Bay,' published in

1789, "were examined with all possible expedition, and the preference was given to one which had the finest spring of water. ………… This cove is about half a mile in length, and a quarter of a mile across at the entrance. In honour of Lord Sydney, the Governor distinguished it by the name of Sydney Cove." In "Collins's New South Wales," published in 1798, it is said that "the spot chosen [for the settlement] was at the head of the cove, near the run of fresh water which stole silently along through a very thick wood, the stillness of which had then for the first time since the creation been interrupted by the rude sound of the labourer's axe, and the downfall of its ancient inhabitants." In this judiciously selected spot, abounding in natural beauty, and possessing many of the features (though by no means all) that ought to mark the site of a great city, the fleet was brought from Botany Bay on the 26th of January. The whole of the people were landed by the 6th of February, and were found to number 1030. Thus was planted the germ, not, it must be allowed, a healthy or promising one, but still not devoid of irrepressible British vigour, which through many vicissitudes and varying fortunes has grown and expanded until in eighty years it has overspread a great portion of this island continent with nearly a million and a half of energetic, self-governing, English-speaking people. At the head of Sydney Cove, and on the banks of the clear running stream, the tents and huts of the infant settlement were erected. It was not long before the supply of water became a source of anxiety, for the stream was scanty, and doubtless sometimes stopped running, but we are told that the people soon began to dig wells, and were successful in finding springs.

By a notice in the *Sydney Gazette* of date October 19th, 1811, it appears that when the settlement was only in its second year, it fell into great straits for want of water. "From the best information we can collect," says the *Gazette*, "so intense a drought at this time of the year has not been witnessed since the year 1789, when the new colonists suffered a parching thirst for several months, the springs from which they had been before supplied either failing totally, or yielding scarcely a sufficiency to supply nature."

As the town increased, wells were multiplied, and the rivulets falling into other parts of the harbour were laid under contribution, particularly the copious stream running into Blackwattle Swamp; but for a number of years the Tank Stream was the main dependence, and strenuous efforts were made from time to time to husband the supply and preserve its purity. Three reservoirs or "tanks" were excavated in the rock near the mouth of the stream, close to the point where Hunter-street and Pitt-street now intersect. I have not discovered the exact date of

the construction of these tanks, but it must be at least as early as 1802, for a "General Order" was issued on the 14th October of that year, and republished in the *Sydney Gazette* of 18th December, 1803, of which the following is an extract:—"If any person whatever is detected in throwing any filth into the stream of fresh water, cleaning fish, washing, erecting pig-styes near it, or taking water up but at the Tanks, on conviction before a magistrate their houses will be taken down, and forfeit £5 for each offence to the Orphan Fund." It is further enjoined that the fences along the stream should be kept in good repair—that no person might have access to it but at the Tanks. Allusion is made to this fencing in the *Gazette* of 16th October, 1803:—"The enclosure of the Tank, undertaken by Government, will, when completed, considerably improve the town in its appearance, and render universal benefit in the preservation of its excellent stream. Every appearance of rubbish has been removed from its sides, and the crystal current flows into the basin with its native purity."

In the "Government and General Orders" of date 15th September, 1810, I find the following:—"It having been represented to his Excellency the Governor, as a very serious grievance, that the Stream of Water which flows through the town of Sydney, and the Tanks which have been constructed thereon (at considerable expense), for the purpose of procuring an adequate supply of pure and good water for the necessary accommodation and benefit of the inhabitants at large, are frequently polluted, and rendered totally unfit for those valuable purposes (which become the more important by the scarcity of wholesome water with which the town is supplied); and it thence becoming an object of the first consideration to the health and comfort of all persons residing within the town of Sydney, that said stream and Tanks should be strictly preserved and guarded against all abuses whatever, his Excellency deems it necessary to issue the following Orders:—

"1. That no necessaries, slaughter-houses, tanneries, dyeing-houses, breweries, or distilleries, shall be in future erected on or near to the said stream, tanks, or springs flowing thereto . . . and further that all . . . [such nuisances] already erected or established thereon, shall be immediately pulled down, or otherwise suppressed, under pain of the owners or possessors being proceeded against, and prosecuted under the Nuisance Act.

"2. That no person shall presume to throw any dirt, rubbish, ashes, dirty water, or filth of any kind into the tanks, or streams supplying them, or into any of the springs or streamlets flowing to and past the said tanks.

"3. That no linen, clothes, or any other article, shall be washed in the said tanks, stream, springs, or streamlets.

"4. That no pigs, goats, sheep, horned cattle, or horses, shall be permitted to drink at, or otherwise render foul, the said waters, or any part of them, under pain of forfeiture of said animals, as already prescribed in his Excellency's public notice, dated 11th of August last."

The next reference that I find to the Tanks, is in the *Sydney Gazette* of March 2nd, 1811. "The long prevailing drought has destroyed every hope of the maize crop, which is unfortunately past recovery. A scarcity of water has also been the consequence, scarcely ever before witnessed. In Sydney the Tanks have been several weeks empty, and those who were in want of water obliged to collect it from small cavities in the spring course above the tanks, which has afterwards been sold at from fourpence to sixpence per pail." Heavy rains fell soon after the date of this notice; and for several years thereafter (with the exception of 1814-5), floods were more characteristic of the country than droughts. So frequent, indeed, were these floods, and so destructive, that fears were entertained that the cultivation of the alluvial flats of the Hawkesbury, on which Sydney then greatly depended, would have to be given up.

In 1820 there were two or three heavy bursts of rain, causing floods, but there was also a continuance of dry weather, which brought out the following notice in the *Gazette* of October 28th:—"The present dry season of the year being indicative of an approaching long drought, which will be much felt throughout the town of Sydney, we presume it would be advisable, as much for the sake of decency as cleanliness, to pay a little if not due regard to the general orders in existence relative to the preservation from all filth and impurity of that valuable and serviceable reservoir—the Tanks. With much pain we have lately observed individuals washing themselves in this stream of water, particularly in that part that runs central from King-street, because that spot is almost secluded from every eye, that of curiosity excepted. In former times the punishment for this offence, it may be recollected, was summarily severe;" and they go on to quote from the General Order of September 1810. In 1823 the *Gazette* (November 6,) again comes out in defence of the water supply, by a republication of the General Order of September, 1810, prefaced by the following words:—"In consequence of certain intelligence having reached us, to the serious injury and annoyance of the inhabitants of the town of Sydney, that the stream of water which flows through the town, and the tanks which have been constructed thereon, at a vast expense to Government, are systematically polluted and rendered totally unfit (if known generally) for the valuable purposes intended, we have thought it advisable to publish the following extract, &c." A drought of some severity began in this year, and continued till towards the

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end of 1824. In the *Gazette* of March 18th of the latter year we read :—" As we have had but little rain since July, water has been scarce in town ; but then it should be gratefully remembered what a providential supply Blackwattle Swamp furnishes in the most dry season. It would be well to build a reservoir or tanks at this spot . . . . The kindness of the Government will, it is humbly presumed, ever secure this spot from the clutches of private individuals." Of course the kindness of the Government did no such thing ; and, indeed, it would have been utterly impossible to preserve the purity of the streams that drain the area on which Sydney stands ; but had anything like the same care been bestowed on the waters that drain into the north side of Botany Bay as was fruitlessly lavished on the Tank Stream, Sydney might have been abundantly supplied at the present day. And yet, perhaps, it was a mere question of time, and it might have been no more possible to preserve permanently the drainage area of Shea's Creek (the chief of the Botany waters lost to the public) than it was to save from defilement the streams flowing into Darling Harbour and Sydney Cove.

The drought of 1823-4—we learn that 35 inches of rain fell in the former year, and only about 19 inches in the latter (*Gazette*, 10th March, 1825)—drew public attention more strongly than ever to the deficient supply of water ; and at the Quarter Sessions commencing on November 9th, 1825, the presentment of the Grand Jury contained the following passage .—" The Grand Jurors have to lament that their repeated presentments of the inadequate supply of Sydney with water have been hitherto disregarded. They have, therefore, again strongly to urge the indispensable necessity of some immediate measures on this subject. The principal stream whence the inhabitants are at present supplied with this necessary article they find still unclosed, and polluted by common sewers, and every description of filthy pools emptying themselves into it, which must render it of highly deleterious quality." And at the Quarter Sessions, in February, 1826, the subject of the water supply is again brought forward in similar terms. The despairing attempts to preserve the Tank Stream, and the pathetic way in which the *Gazette* holds up its condition, have not a little of a comic element. " We actually beheld," says the *Gazette* of 1st March, 1826, " upwards of half a dozen boys bathing in the very stream from which, it is most probable, the next moment many of the inhabitants of Sydney were obliged to supply themselves with water for culinary purposes." These representations, equally with the authoritative orders of Government, were all in vain. Nothing could save the Tank Stream, Its inevitable destiny was to become a filthy sewer, and, in that capacity, it has long been covered over and hidden from public view. After 1826 I find no farther

reference to it as a source of water; and, indeed, if you consider its limited drainage area it is remarkable that it should have served Sydney so long. If a person start from the Custom-house, and proceed (by Bridge-street and Macquarie-street) to the middle of Hyde Park, then across to Bathurst-street, thence to George-street, and round by the Police-office to York-street, thence to Church-hill, and back to the Custom-house by Bridge-street, he will have enclosed (in a circuit of about two miles) the whole area drained by the Tank Stream, amounting to no more than 178 acres. Part of this area, however, was well fitted for the retention of water; for I have been informed by an old colonist that a spongy swamp once stretched from about the position of King-street back towards Park-street, and laterally towards George and Castlereagh streets,—such a swamp as may still be seen in several places near Sydney, giving rise to streams of a remarkably permanent character.

The year 1826 began with heavy rain and floods, but soon changed to a prolonged drought, which must have helped materially to bring the question of water supply to a crisis. This year, says Captain Sturt, commenced "one of those fearful droughts to which we have reason to believe the climate of New South Wales is periodically subject. It continued the two following years with unabated severity." If we consider further that the population of Sydney now amounted to 10,000, it will be understood that a new and more abundant source of water was imperatively needed. In 1824, Mr. John Busby had arrived in the colony with the appointment of Mineral Surveyor to the Government, and his labours were soon turned by Sir Thomas Brisbane to a search for water. After examining several localities near Sydney, he ultimately reported (in 1826) in favour of the Lachlan Swamp, lying to the south-east of Sydney, in the hollow between Paddington and Randwick. Mr. Busby's plan was adopted, and the work of driving a tunnel from Hyde Park to the Swamp was commenced in September, 1827. From the unmanageable and unskilful character of the labourers employed (convicts), and from unforeseen difficulties in the strata that had to be gone through, the undertaking was much more tedious and difficult than had been anticipated, and it was not till June, 1837, that it was brought to a successful termination. The tunnel, however, began to supply Sydney with water as early as 1830, by virtue of drainage from the surrounding rocks. The whole length of the tunnel is 12,000 feet, upwards of $2\frac{1}{4}$ miles—with an average width of four feet, and height five feet. Twenty-eight vertical shafts were sunk from the surface, varying in depth from twenty to eighty feet; the whole mass of excavation amounted to 255,930 cubic feet, fully nine-tenths being through solid rock; and the total cost was £24,000. The catchment basin of the

Lachlan Swamp is about two square miles, but probably only about half of that area actually drains into the tunnel; and as no provision is made for retaining storm-waters at the swamp, a great proportion of the rainfall runs down to Botany Bay. The tunnel remains in good order to the present day, and is used to supply the lower parts of Woolloomooloo and a portion of the city along Darling Harbour, between Bathurst-street and Erskine-street. The termination in Hyde Park is about 104 feet above high water mark. The daily delivery varies much with the state of the weather, but it may be taken at somewhere between 300,000 and 400,000 gallons, which at the time the tunnel was opened was a fair supply for the population of 20,000 that then existed in Sydney. This quantity represents less than one-fifth the annual rainfall on the area draining into the tunnel. An important feature of the original sheme was to have a reservoir excavated in Hyde Park capable of holding fifteen million gallons, but this unfortunately was never carried out.

Soon after the opening of the tunnel there commenced a calamitous drought, the severest and most general of which we have any record. Cotemporary accounts represent the colony as reduced to great straits through the destruction of vegetation and live stock. One writer says:—"No words can express the miserable appearance of the country. . . . There is neither food for man nor beast. . . . God knows what will become of us all if some change does not take place very soon." I regret that I can find no record of the rainfall at Sydney, or at any other part of the colony, for the years 1838-9, during which the drought prevailed; but in Captain Stoke's *Voyage of the Beagle* there is a distinct assertion of the total absence of rain for a period of perhaps eight or nine months He says:—"For some time previous to our former departure from Sydney, during the whole of our absence, and for several months subsequent to our return, not a drop of rain fell." Now the Beagle left Sydney on the 11th November, 1838, and returned 10th March, 1839. The close of the above period must have been May 29th, for I find this recond in the *Herald* of May 31st:—"It rained very hard in Sydney on Wednesday night, blowing a perfect gale of wind." It is usually stated, however, that the drought did not break up till October.

There is evidence that, during this distressing period, the tunnel never altogether stopped running, although the supply became scanty. Even so early in the drought as 5th November, 1838, I find this statement in the *Herald*,—"Great distress exists in Sydney, especially at the northern end, in consequence of the scarcity of water. The stream from the pipes on the racecourse is very small—so small that the men cannot fill the water-carts without waiting four or five hours for a turn. Threepence per

bucket is the price now asked—a heavy tax upon poor people." I have been assured by a gentleman who lived in the northern part of Sydney at that time that he had to pay as much as sixpence a bucket. The increasing deficiency of water led the authorities to look about for some fresh source, and the dam at Cook's River was begun about that time with the view of increasing the supply. Speaking of the disposal of some prisoners, the *Herald* of 13th May, 1839, says,—"The men are to serve the probationary period at Cook's River stockade, where they will be employed at the dam which is to supply Sydney with water" This dam when constructed was not found to exclude the salt water, and no farther steps were taken in that direction.

The great drought of '38-39 was succeeded by nine years of abundant rain and frequent floods. During this wet period the tunnel seems to have kept Sydney pretty well supplied—at least I find no records of scarcity, nor of schemes for increasing the supply—but in the year 1849 there occurred a drought of considerable severity, and the water question again started into prominence. In that year the rainfall, as measured at South Head, was only 21½ inches (the average being about 50 inches), while the population of Sydney had increased to about 40,000, or double what it was when the Lachlan swamp was first tapped. I find that in April, 1849, the Water Committee of the City Council directed the City Surveyor (Mr. F. Clarke), to examine the swamp and tunnel with the view of improving the supply. The surveyor sent in his report in December, recommending that a dam should be carried across the lower part of the swamp, so as to form a lake of 40 or 50 acres, with an average depth of four feet, and to construct a reservoir of masonry near the east end of the tunnel 25 feet higher than the lake, and capable of holding 10 million gallons; this reservoir to be filled by pumping from the lake. A commencement of the proposed dam was made, but it was soon abandoned, and the remaining part of the recommendation was neglected. The next movement was the appointment, in January, 1850, of a special committee of the City Council "to inquire into and report on the best means of procuring a permanent supply of water to the city of Sydney." This committee did not close their labours till February, 1852, when they sent in a long and carefully-compiled report, the result evidently of a laborious investigation of the whole question. This report gives the population of Sydney at nearly 50,000 (the census of 1851 gave about 45,000, and there was a large accession about that time in consequonce of the discovery of gold); the number of houses 8482, of which only 2300 were supplied with water; the assessed annual valne of city property, £232,678; and the gross water revenue, £3493. In discussing the mode of improving the water supply temporarily, the report condemns

the embankment proposed by Mr. F. Clarke, and recommends instead that a trench should be dug at the lower part of Lachlan Swamp, and the water pumped from thence to a reservoir at Paddington, 207 feet above sea level. With regard to a permanent supply, the relative merits of George's River, Cook's River, the Nepean, and Lord's Dam at the mouth of the stream draining the Lachlan and other swamps, are discussed, and the preference is given to the last-named source. It is recommended, however, that this supply be supplemented by the drainage eastward as far as Bunnerong, and westward to Shea's Creek and Cook's River. Before any action could be taken on this report—before indeed it was handed in—the Governor (Sir Charles Fitz Roy) appointed in January, 1852, a board of five gentlemen to examine the question afresh. Their report (remarkable chiefly for its length) was laid before the Legislature in August of the same year. They did not take up, as the City Committee had done, the merits of different schemes, but restricted themselves to an examination of the Botany Swamps, as being undoubtedly the best available source; and they recommended that the stream flowing down from Lachlan Swamp should be intercepted at a point about a mile and a half above Lord's Dam, and the water pumped up to a reservoir at Paddington, capable of holding twelve million gallons. They held that a supply of about twenty gallons per head would be sufficient, while the City Committee assumed that forty gallons ought to be provided.

On the 1st January, 1854, the management of the city passed from the hands of an elective Council to three Commissioners appointed by the Governor; and this arrangement lasted for three years. The Commissioners took up zealously the question of water supply, and passed speedily from inquiry to action. In 1854 (a very dry year in Sydney), they erected a small pumping engine at the lower part of the Lachlan Swamp for the purpose of throwing more water into the tunnel,—by this adding about 150,000 gallons to the daily delivery; and at the same time they entered on the necessary preliminaries for obtaining a new and more abundant supply from the lower end of the stream; at Lord's Dam It was not, however, till November, 1858, that the pumping engines at Botany were set to work, and that system of of supply commenced which we enjoy at the present time. Since then we have experienced some very dry seasons, and occasionally the pumps have not been fully served by the stream; but the Municipal Council has always been on the alert, and on the whole, Sydney has been fairly supplied with water. Every dry season, however, has stimulated a fresh inquiry. In 1862 only 24 inches of rain fell, and a select committee of the Legislative Assembly was appointed to investigate the state of the water reserves. 1865-6 were rather dry, (each year giving about 36 inches of rain),

and the latter part of '67 very dry, with only $9\frac{1}{4}$ inches in six months, which had the effect of starting inquiry once more, In September, last year, a Royal Commission was issued, appointing five gentlemen to take up the search for a more abundant and trustworthy supply of water, and these Commissioners have not yet sent in their final report.

The present state of the supply is this:—At Lord's Dam, the drainage of nearly seven square miles falls into Botany Bay The pumping establishment there comprises three steam engines of 100-horse power each, two of which are generally kept going night and day. The total quantity pumped last year was 956,000,000 gallons. A 30-inch main, about four miles long, leads to two reservoirs, one at Crown-street, 139 feet above the sea, holding $3\frac{1}{2}$ million gallons, and the other at Paddington, 214 feet above the sea, and holding $1\frac{1}{2}$ million gallons. As these reservoirs contain less than two days' supply, and as the great defect of the system is the want of storage for water in wet seasons, efforts have recently been made to form dams on the Botany stream, so as to preserve a surplus in wet seasons to make up the deficiency of dry. Six of these dams were constructed, but three were partially destroyed by heavy floods in the early part of this year. Had they remained efficient they would have provided (along with the two ponds near the engine-house) storage capacity for 250,000,000 gallons. The total cost of the works for supplying Sydney (including the two service reservoirs, but excluding the cost of distribution) has been nearly £150,000. The cost of pumping up the water last year was £4700; and if to this we add the interest on cost of plant, we find the total cost of supplying Sydney (still excluding the distribution) to be about £33 per day, or less than half a farthing per head of the population supplied. The water is distributed through the whole of Sydney proper, together with the municipalities of Glebe, Darlington, Redfern, and part of Paddington, by about 105 miles of piping.

When the present system of supply was completed in 1858, the population of Sydney and suburbs was about 87,000. At the present time it must be about 118,000. Of this number, about two-thirds share in the public supply of water; and adding the quantity delivered by the tunnel to that pumped from Botany, it appears that the distribution is at the rate of nearly forty gallons per head,—a fair supply, if only it could be kept up and fairly distributed, and all could share in it. But we have no sufficient provision for a long drought, and there is nothing to spare for thousands of people in the suburbs, or for the natural increase of our population. Supposing, however, that these defects were remedied, we should not rest content with 40 gallons per head. In a hot climate like this there ought to be a super-

abundance of water, as well for public health and safety as for personal comfort and convenience. Sydney, however, is not favourably situated for an abundant supply, and it cannot be procured without enormous outlay. The words of Sir Thomas Mitchell, in his evidence before the City Committee, in 1850, are as true and forcible now as then—"I cannot but see that the weakest point in the character of this great city, for a great city it is likely to be, is the present insufficient supply of water; I should therefore desire a more certain source."

Art. VI.—*On the Results of Wheat Culture in New South Wales for the last ten years, by Christopher Rolleston, Esq.*

[Read 2nd December, 1868.]

In a paper which I read before the Philosophical Society in the year 1864, there was exhibited a succinct view of the results of the agricultural industry of New South Wales for the ten preceding years. I propose here to inquire into the progress of the colony in that particular branch of husbandry upon which we principally depend for the supply of food for the people, and I have thought it would be interesting to ascertain by reference to the annual returns where wheat culture has been making the greatest progress, and has yielded the largest results. In order to avoid encumbering the inquiry with too minute details, I have apportioned the colony into five divisions, namely, Southern, Western, Northern, Midland, and Pastoral. The four first divisions embrace the old settled counties, and the fifth includes the whole of the pastoral districts outside the limits of the old counties.

The table embraces the ten years from 1858 to 1867 inclusive, and is arranged in quinquennial periods to show the relative progress and results of the culture of wheat in the two periods.

SOUTHERN DINISION.

1.—We will take the Southern Division first. It embraces the counties of Argyle, King, Georgiana, Murray, and St. Vincent. It appears that the acreage under wheat in the first five years, 1858 to 1862, averaged from 14,003 acres up to 24,718 acres, the lowest number being that for 1858, and the highest that for 1861. The average was 19,519 acres. The produce ranged from 19·5 bushels per acre in 1858 down to 9·9 bushels per acre in 1862.

The average of the five years being rather over 14 bushels per acre.

The second quinquennial period from 1863 to 1867 shows a range of cultivation commencing with 26,438 acres in 1863, increasing to 45,739 acres in 1866, and dropping to 30,051 acres in 1867. The average of the five years being 31,841 acres, or 63 per cent. above the average of the previous five years.

The yield per acre ranged from 9·4 bushels in 1863 up to 15·4 bushels in 1866, and dropped to 10·7 bushels in 1867. The average was rather over 10 bushels—that is a lower average yield by 4 bushels per acre than in the previous quinquennial period.

The average yield of the ten years is thus reduced to rather better than 12 bushels per acre.

The price of wheat has ranged during the same period from as low as 5s. per bushel up to 12s—the average being about 7s. 10d. This would give an average yield to the grower of about £4 14s per acre.

WESTERN DIVISION.

2.—The Western Division comprises the counties of Bathurst, Roxburgh, Phillip, Wellington, amd Bligh. The acreage under wheat in the first five years ranged from 10,483 acres in 1858 up. to 27,761 acres in 1859, and then fell to 17,390 acres in 1860, and downwards to 13,505 acres in 1862. I have reason to think that the large excess in the year 1869 is attributable to some error in the returns for the counties of Phillip and Wellington for that year, which it is impossible to arrive at a satisfactory explanation of at this period.

The average for the 5 years was 17,025 acres.

The produce ranged from 20·1 bushels in 1858 down to 9·8 bushels in 1862, the average being about 14½ bushels per acre.

The second quinquennial period of this division exhibits a range of cultivation commencing with 19,846 acres in 1863, and increasing up to 60,026 acres in 1867, the average being 37,704 acres, an increase of 121 per cent. upon the average of the first 5 years. I have reason, however, here again, without wishing to throw a doubt upon the accuracy of the returns, to notice a remarkable extension in wheat culture in the counties of Wellington and Bathurst in the years 1866 and 1867. I find that the acreage under wheat increased, in the county of Wellington, from 3368 acres in 865 to 15,777 acres in 1866 and to 17,399 acres in 1867; and in the county of Bathurst from 16,922 acres in 1865 to 30,753 in 1866, and to 31,060 acres in 1867. I have been unable to arrive at any satisfactory solution of the question, being assured that the returns are accurately made up; but I find that it is in the police district of Orange that the remarkable increase is shown, part of that district being situated in the country of Wellington, and part in the county of Bathurst. Perhaps the

question being thus prominently noticed may stimulate the local authorities to inquiry, and, if there is any error, to its correction in the returns for the present year.

The yield per acre ranged from 16·7 bushels in 1864, to 8·1 bushels in 1867; the average being about 10½ bushels, or about 3 bushels per acre less than the average yield of the five previous years.

The average yield of the ten years is thus reduced to about 12½ bushels per acre, or about half a bushel per acre over the yield of the Southern Division.

Taking as before, the average price at 7s. 10d., we arrive at the result of £4 17s. 11d. per acre as the gross average return from wheat growing in this division, *i.e.*, 3s. 11d. per acre more than seems to fall to the lot of the Southern farmers.

NORTHERN DIVISION.

3.—We come now to the consideration of the returns for the Northern Division, which embrace the county of Northumberland, Durham, Gloucester, Hunter, Macquarie, Brisbane.

Here we find the acreage in wheat commencing with 30,415 acres in 1858, and ending wiih 24,646 acres in 1862; the average of the five years being 30,663 acres.

The yield during the first period ranged from 13·3 bushels in 1858, to as low as 10·3 bushels in 1861, and up again to 12·7 in 1862, the average being under 11½ bushels per acre.

In the second quinquennial period we find the extent of wheat tillage for grain commencing with 19,086 acres in 1863 dropping to 13,001 acres the next year, and ending with 15,837 acres in 1867, the average being 17,132 acres, a decrease of nearly 80 per cent. upon the average of the previous five years.

Looking to the yield per acre, we soon find a reason for this declension.

The first year of the period (1863) shows a yield of only 4 bushels per acre, and the largest yield (in 1865) only 10·3 bushels —the average of the five years being under 7½ bushels per acre; that is 4 bushels per acre below the yield of the first five years. The average yield of the ten years is thereby reduced to less than 9½ bushels per acre; that is, 2½ bushels less than the average yield of the Southern division, and 3 bushels less than the Western.

Taking the average price of wheat as before, at 7s. 10d. per bushel, we deduce a pecuniary result to the farmer in this division of about £3 6s. 4d. per acre. When we work out such a result as this, as exhibiting the gross proceeds from wheat culture in the Northern districts of the colony, we cannot be surprised at the evidence thereby afforded of its gradual abandonment.

MIDLAND DIVISION.

4.—We come now to the midland division, embracing the counties of Camden, Cook, Cumberland, and Westmoreland, and here we discover more unsatisfactory results than we have noticed in the Northern division.

We begin the first quinquennial period with an acreage ranging from 26,757 acres in 1858, increasing to 35,701 acres in 1860, and again decreasing to 28,361 acres in 1862, the average being 30,543 acres.

The yield during this period commenced with 15·8 bushels per acre in 1858, and dropped to 5·1 bushels in 1862; the average being rather over 11 bushels per acre.

The second quinquennial period opens with an acreage of 20,660 acres, and closes with 8,393 acres, showing an average of 14,121 acres, and a decrease of 115· per cent. upon the average of the previous five years.

The yield during this period opens with figures representing an almost total failure of crop,—namely, 1.9 bushels per acre in 1863, and closes with 7·4 bushels per acre in 1867; the average yield being under 5½ bushels, or being nearly 6 bushels per acre less than the average of the previous five years. The average of the ten years is thereby reduced to a little over 8 bushels per acre; that is, 1½ bushels below the Northern division, 4 bushels below the Southern, and 4½ below the Western.

Taking the average price as before, at 7s. 10d. per bushel, we arrive at a gross result to the farmer of £3 2s. 8d. per acre for his efforts, toil and trouble in the production of the staff of life in this division of the country.

5. Throwing together the results brought out in each of the foregoing divisions, we find that we commenced the first quinquennial period with a breadth of land in wheat of 81,658 acres, which increased in 1860 to 110,291 acres, and subsided again in 1862 to 88,568 acres; the average of the 5 years being 97,746 acres. The yield in 1858 was at the average rate of 16 bushels to the acre; and in 1862 was little more than 9 bushels; the average yield of the 5 years being under 12½ bushels per acre.

In the second five years we commence with 86,030 acres under wheat cultivation, which fell to 78,955 acres in 1864, rose again to 88,306 acres in 1865; and, owing in a great degree to the extraordinary increase in the district of Orange, already noticed, reached 136,896 acres in 1866 and fell again to 114,307 acres in 1867, the average of the five years being 100,899 acres, an increase of a little over 3 per cent. on the first quinquennial period.

The yield of wheat in this period ranged between 7 and 11½ bushels, the average being only 9 bushels per acre, or about 7½ bushels under the average of the previous five years.

The depressing influence of bad crops is very manifest throughout the whole of the period under review in the diminished cultivation of the following year, and we are almost surprised that in the Midland and Northern divisions wheat culture is not altogether abandoned.

PASTORAL DISTRICTS.

6. We will turn now to an examination of the returns from the comparatively virgin soils of the Pastoral Districts. Here we find 13,020 acres sown in wheat in 1858, increasing up to 19,566 acres in 1862; the average of the 5 years being 16,458 acres.

The yield commenced with 19·2 bushels in 1858, and gradually dropped to 12·3 bushels in 1862—the average being a little over 15 bushels per acre, that is 3 bushels in excess of the average of the old settled counties in the same period.

The second quinquennial period commences with 17,909 acres under wheat, increased to 42,344 acres in 1865, and drops again to 34,832 acres in 1867; the average being 31,965 acres, an increase of 91 per cent. upon the acreage of the previous five years.

The yield ranged from 11·1 bushels per acre in 1863 up to 17·2 in 1866, and fell again to 12·6 in 1867—the average of the five years being rather under 12½ bushels; that is about 2½ bushels below the average of the earlier quinquennial period, and about 3½ bushels over the average of the old settled counties in the corresponding period.

Looking to the results of the ten years over the whole colony, we find that in the first five years there was an average annual breadth of land laid down in wheat for grain of 114,204 acres, with an average yield of 1,482,998 bushels, being at the rate of 13 bushels per acre; whilst in the second five years the average annual breadth of land sown in wheat for grain was 132,864 acres, with an average yield of 1,345,814 bushels, being at the rate of 10 bushels to the acre.

Such are the results of an investigation into the statistics of wheat-growing in New South Wales since the year 1857. They are not encouraging to the prosecution of this branch of agriculture, and yet the farmers of South Australia set us an example of industry and perseverance in this very branch of husbandry, under circumstances, but little, if at all, more encouraging; for I find that in a corresponding period to that which we have been reviewing, their average yield has very slightly exceeded 10 bushels per acre. It has been as low as 4 bushels per acre, and as high as 14, and they are glad to sell their wheat *on the ground* at 3s. 6d per bushel.

RETURN OF ACREAGE UNDER WHEAT IN NEW SOUTH WALES; with Produce, in bushels and yield per acre, for the Years 1858 to 1867 inclusive.

	1863.	1864.	1865.	1866.	1867.	Average.
SOUTHERN DIVISION :—						
Acres	26,438	27,969	29,506	45,739	39,051	
Bushels	250,186	303,226	128,092	706,844	322,830	
Yield per acre	9·4	10·8	4·4	15·4	10·7	10·1
WESTERN DIVISION :—						
Acres	19,846	23,700	28,516	56,435	60,026	
Bushels	244,944	396,081	193,330	606,752	490,165	
Yield per acre	12·3	16·7	6·7	10·7	8·1	10·9
NORTHERN DIVISION :—						
Acres	19,086	13,001	16,655	21,081	15,837	
Bushels	76,396	122,823	171,729	174,175	114,022	
Yield per acre	4·0	9·4	10·3	8·2	7·2	7·4
MIDLAND DIVISION :—						
Acres	20,660	14,285	43,629	13,641	8,393	
Bushels	39,248	83,994	89,412	80,131	61,840	
Yield per acre	1·9	5·9	6·5	5·8	7·4	5·5
TOTALS.						
OLD SETTLED COUNTIES :—						
Acres	86,030	78,955	88,306	136,896	114,307	
Bushels	610,774	906,124	582,563	1,567,902	988,857	
Yield per acre	7·0	11·4	6·6	11.4	8·6	9·0
PASTORAL DISTICTS :—						
Acres	17,909	25,609	43,344	38,133	34,832	
Bushels	198,145	340,333	431,298	658,125	440,950	
Yield per acre	11·1	13·3	9·9	17·2	12·6	12·8
GRAND TOTALS.						
ACRES	103,939	105,564	131,650	175,029	149,139	
BUSHELS	808,919	1,246,458	1,013,863	2,226,027	1,433,807	
YIELD PER ACRE	7·7	11·6	7·7	12·7	9·5	9·9

	1858.	1859.	1860.	1861.	1862.	Average.
SOUTHERN DIVISION:—						
Acres	14,003	16,772	20,078	24,718	22,056	
Bushels	273,867	192,825	288,432	405,616	218,013	
Yield per acre	19·5	11·5	14·3	16·4	9·8	14·3
WESTERN DIVISION:—						
Acres	10,483	27,761	17,390	15,985	13,505	
Bushels	211,424	454,673	258,488	209,980	132,474	
Yield per acre	20·1	16·3	14·8	13·1	9·8	14·8
NORTHERN DIVISION:—						
Acres	30,415	30,102	37,122	31,032	24,646	
Bushels	403,904	344,611	418,899	318,589	318,504	
Yield per acre	13·2	11·4	11·3	10·2	12·9	11·8
MIDLAND DIVISION:—						
Acres	26,757	28,957	35,701	32,938	28,361	
Bushels	424,665	419,296	318,389	408,407	145,525	
Yield per acre	15·4	14.5	8·6	12·3	5·1	11·1
TOTALS.						
OLD SETTLED COUNTIES:—						
Acres	81,658	103,542	110,291	104,673	88,568	
Bushels	1,313,860	1,411,405	1,284,208	1,342,592	814,516	
Yield per acre	16·1	13·6	11 6	12·8	9·2	12·6
PASTORAL DISTRCTS:—						
Acres	13,020	12,382	18,531	18,791	19,566	
Bushels	250,196	193,948	297,389	263,542	240,438	
Yield per acre	19·2	15·6	16·0	14·0	12·3	15·2
GRAND TOTALS.						
ACRES	94,678	115,924	128,822	123,464	108,134	
BUSHELS	1,564,056	1,605,353	1,584,597	1,606,034	1,054,954	
YIELD PER ACRE	16·5	13·8	12·2	13·0	9·7	13.0

Art. VI.—*Remarks on the Dry Earth System of Conservancy, by Edward Bedford, Esq. F.R.C.S.*

[Read 2nd December 1868.]

It is several months since a commission sat to enquire into the effects of pouring the sewage of the city into the harbour. The immediate cause of the enquiry was the mechanical disturbance, by the filling up of parts of the harbour by the deposits brought down by the sewers; other questions rose in this enquiry.

It is not my intention to go into the question examined by that commission, nor to enquire if any other system than the drainage by water is safer to the health, or otherwise more useful and economical; but to draw the attention of the members of this society, and of the public, to a very important question affecting the suburbs of Sydney, where drainage is not established.

The suburbs of Sydney are only partly supplied with water by pipe service, and in the absence of such service no sewerage by means of water can be carried out, and these suburbs, therefore, are not relieved of sewage, and the drinking water is supplied from wells. It is understood that polluted soil may be made the means of deteriorating the health of the people in its vicinity, and if that polluted soil is studded with the wells, disease may also be conveyed with the water from these wells.

It is a general opinion that the poisons of cholera and typhoid fever are conveyed by water from the excreta of patients suffering from these diseases.

Ground pierced by cesspools must pass into the surrounding ground their fluid contents, and if this ground is also pierced with wells, the wells will, as a rule, be of greater depth than the cesspools, and the wells will then form not only the store house for the drinking water, but also for the drainage from the adjoining cesspools; and the water from these wells may become the source of some particular form of disease, as well as being the the cause of a general impairment of health. Also from the open mouths of these cesspools, gasses arising from the decomposition of their contents constantly pass into the air.

It is well known that a system of dry earth conservancy has been for some years carried out in different localities, and particularly in public establishments in India.

That the system can be worked, I am quite sure, not only from the reports I have read from India on this subject, and the notices

of its more recent adoption in various establishments in England, but it has, at my suggestion, been put in operation in the Military Barracks at Paddington, when I was in medical charge there in 1864 and 1865.

In July, 1865, I addressed a circular letter enclosing a memorandum to each of the suburban municipalities, and I read them to you as they will shew the advice I tendered, and explain the plan proposed.

"July, 1865.

"Sir,—I do not offer any apology for addressing you on the subject, as the interests at stake are so great, and the duty of guarding the public safety with reference to them is entrusted to your care.

"I will not waste your time with remarks upon the necessity of getting rid, by some effective means, of the sewage from houses,

"I need not offer any observations upon the cost of a good drainage system,—it has been realised in the money laid out in Sydney; while expense alone should not be considered in keeping a locality in a condition not to produce or increase disease. Yet, if that object can be most completely done at a small, instead of a large, expenditure, it is much more to the interests of the ratepayers.

"There are states of population where few houses are scattered over a large area, where such a system of sewage drainage would be most costly, and, from expense alone, perhaps impossible.

"It is desirable to keep the ground of such localities free from the constant contamination of leakage from extensive cesspools.

"This is seen to be requisite in a cold climate like England, it becomes doubly imperative in a warm climate with an uncertain supply of water.

"I have for years been aware of modifications of the earth system of conservancy. My attention has been more particularly directed to this subject by an article in the *British and Foreign Medico-Chirurgical Review*, in which reference was made to the adoption of the dry earth system in barracks, hospitals, and prisons in Madras.

"I have obtained from Madras two pamphlets:—One, the "Reports and Orders of the Madras Government regarding the adoption of the dry earth system of conservancy, being extracts from the proceedings of the Madras Sanitary Commission, under the presidency of the Hon. R. S. Ellis, C. B.' The other, "On some unsolved Problems in relation to Public Health,' by W. R. Cornish. These works prove the great advantages of this plan in the hot climate of India.

"The simplicity of the plan, the small cost at which it can be carried out, the use of the material for agricultural purposes, its peculiar applicability to all suburban localities and to large estab-

lishments, render its careful consideration by all municipal and other governing authorities a matter of great importance.

"I enclose a memorandum, which describes the process, its benefits, and success; and I commend it to your consideration.

"The poor soil which surrounds Sydney renders it very desirable that the ground for garden and agricultural purposes should be supplied with manure at as cheap a rate as possible ; the dry earth system may be made of great benefit in this respect, and the cost of conservancy reduced very considerably—perhaps to nothing, while the improvement of the land wiil be of the greatest importance.

"In your municipality you are not bound down by any established sewage system, it is therefore open to you to introduce this plan, and to keep the land free from the impurities that must arise in the absence of any proper arrangement for the complete removal of sewage from houses.

"I have the honour to be, Sir, your obedient servant,

(Signed) "E. S. P. Bedford.

"P.S.—I have forwarded a similar communication to the other municipalities."

MEMORANDUM.

,, A model system of dry earth conservancy should aim at two things—*a*. The deprivation of the substance to be conserved of its natural moisture, with the view of suspending putrefaction and waste. *b*. The restoration to the soil of the animal excretions, with their fertilising properties unimpaired. Material points to be remembered are:—1. That a sufficient quantity of dry earth, properly sifted, be stored under cover for use ; this must be particularly attended to before rain. 2. That the dry earth and excreta "poudrette" be removed daily and deposited, protected from rain. 3. That wherever it may be necessary to erect latrines, they be constructed on a plan suitable for the dry earth system, and approved by authority. No wooden tubs should be used, but iron receptacles, tarred within, and those for urine three-quarters filled with dry screened clay. When the earth requires screening it must be done before the earth is taken to the latrine. A box with dry earth, with a scoop to be placed in the privy, and a scoopful is required to be thrown in on each occasion of its use. The earth might be applied mechanically. Simple instructions to persons using hospital or public latrines should be placed in conspicuous places. The quantity of earth required each day will not be less than eleven pounds for each person, and if of unsuitable quality, seventeen pounds. Two pounds of pure clay absorbs one pound of water as completely as six pounds of earth composed principally of sand and gravel. The most suitable is clay, with a

moderate admixture of sand; gases do not readily form in it, but if the surface becomes moist, decomposition takes place on the surface, which should be covered with dry earth as often as it appears. The dry earth system is the best that could be devised for a country where the temperature is always high; the putrefactive process in decaying organic matter rapid, and the water supply scanty. Whenever the temperature of water rises above 60° Fahrenheit it ceases to absorb gases well, and becomes therefore a bad vehicle for the removal of organic matter in a state of decomposition. Dr. Blacklock, who made most careful experiments on this question at the General Hospital, at Madras, of which he is a physician, states:—"In private I have tried almost every obtainable deodoriser in close stools, but none have acted so perfectly as dry, or even damp earth. All the chemical deodorisers are objectionable, as although they put away the bad odours at the moment of application, they soon permit decomposition to commence again, and the new odour is often worst than the first. The earth on the contrary not only at once effectually arrests decomposition and its bad ordours, but also never allows putrefaction to commence again till the mass is wetted. I consider the dry earth system for latrines the greatest boon that has ever been conferred on this hospital." Dr. Mouatt, Inspector-General of Gaols, Lower Provinces, states in a report to the Government, "that the earth conservancy has been introduced into all the gaols in Lower Bengal with complete success." Of the utility of this poudrette for agricultural purposes, there is not any doubt; and it might be used for this purpose if well ploughed or dug into the ground. In New York it is largely purchased by market gardeners, and the proprietors of flower gardens prize it highly. I therefore wish to draw your attention now to the ready means for protection of the suburban districts of Sydney from the evils they are, many of them, now exposed to; and should cholera arrive it will be too late, at the first visitation, to prevent much mischief; but if this simple plan is carried out, I believe the suburban districts, though undrained, would be better protected than the city."

To-day I received a note from a gentleman, which he allows me to refer to, and it says, with reference to dry system of sewage — "That he allows no other in his own premises. My whole garden is not more than one-fifth of an acrea, and half rock and slope and yet the whole refuse from the kitchen, bedrooms, and closet is not enough fully to manure one-tenth of it, showing what every house immediately out of the main streets could get rid of all its refuse by turning it into trees and flowers. I hope to see the day when every hundred or two houses will be placed under the care of a gardener, who will go daily and bring away the refuse, and render cities flower instead fever beds.

I am glad to be able thus to assure you how easily the system may be carried out in the places I have indicated.

If I have drawn a true picture, it is clearly the duty of the rural municipalities to adopt means for at once carrying the system into operation.

Article VIII—*On Pauperism in New South Wales, by Alfred Roberts, Esq.*

[Read 9th December, 1869]

Having always thought that the consideration of subjects connected with Social Science would be as acceptable to the members of this society, as it would be beneficial to the community,—I do not feel called upon to offer any apology for introducing to your notice one that is somewhat alien to the nature of those which have hitherto been submitted to your attention. My object is to induce discussion upon an important social topic, and thus, if possible, strengthen the position of those who are called upon to deal with it practically,—I am fully sensible that I cannot treat of "Pauperism" exhaustively, or offer new views respecting it—and that the natural aversion which exists on the part of the educated classes in England to enter fully into matters of this nature, prevails to a greater degree in our young and prosperous community. It is evident, however, that a subject of so much importance cannot be shirked by avoiding it; we may perchance obtain a brief respite, but only to be compelled to face the evil in a more advanced and confirmed stage. Pauperism is a disease for which remedies must be vigorously applied in its earilest stage. I trust, therefore, that others more capable, and with more time at their disposal may be induced to take up the discussion which this paper is intended to open, and that practical results may arise from it.

It is quite unnecessary that I should trouble you with any sensational aspect of the mode in which our infirm and poor are at present relieved. The efforts hitherto made may, upon the whole, be considered to have proved successful, as they are undoubtedly humane in principle. We are called upon to consider them only,

because a time has arrived when the capabilities of the existing system appear to be unequal to the increasing demands made upon it, and because the progress of the colony demands the distribution of its poor. In the same way the advisibility of possessing a system of "poor law relief," does not require our attention, because we already have one, the existence of which is a necessary part of our social economy. It is now generally admitted, that the principle upon which provision should be made for the destitute poor is that of "necessity," and, as such, should not be confounded with "charity." Accepting this, it follows that actual destitution presents the only claim to relief, or, to use the words of Mr. J. S. Mill, "the State cannot undertake to discriminate between the deserving and the undeserving indigent, it owes no more than subsistence to the first and can give no less to the last." It results from this train of reasoning that no one can be a proper object for the poor-law relief unless he is unable to earn his own livelihood. It also follows that the amount of relief to be given to the pauper must be neither more or less than is absolutely essential, in order to make provision for his *immediate* wants. These considerations lead us to a clear conception of the fundamental principles upon which the Poor-Law relief should be based, and show how wide is the difference between their aim and that of "*charity*"—the true province of which is "to seek out the deserving and reject the dissolute." A recent review says—*Poor laws* are said "to exist for the protection of society, while *charity* operates for the benefit of the individual."

"No doubt theoretical distinctions which exist between the province of charity and that of the Poor Laws will be found very difficult of application; but this does not detract from the value of the principles upon which these distinctions are based—on the contrary, being our only guide, we must do our best to keep these principles continually in view, for we are well assured that whenever *charity* does the work of the *Poor Laws*, or the *Poor Laws* that of *charity*, the results are equally disastrous. It is owing to the difficulty of fixing the exact limits within which the Poor Laws should operate, that their administration has always presented difficulties of no ordinary description. The struggle in England has continually been between the two extremes—of making these laws the channel of a wholesale distribution of alms amongst the poor, or the means of attempting to choke down pauperism by a wholesale denial of necessary relief. One of the most instructive lessons in the history of pauperism, is that to be derived from this century's experience. The story of the system of relief in operation at the commencement of this period has been often told, though we fear too often forgotten. There was no 'workhouse' system then in operation, the use of the poor-houses of those days being chiefly confined to the aged and infirm. There was a wholesale system of out-door relief. Intended at first to supply the wants of

the disabled and the infirm, the relief thus granted out of the parish rates became ultimately used as a means for supplementing inadequate wages, thus throwing part of the expense of the payments for labour upon other classes than those by whom the labourer was employed. Perfectly able-bodied labourers, well capable of earning their own livelihood, had their rent paid by parish overseers, and were supplied with 'bread money' for their families, as a matter of course. These proceedings had the effect which might have been easily anticipated, viz., to reduce the scale of wages. Allowances were then given in aid of wages, and a gigantic system of fraud and corruption sprang up under which the independent labourer actually stood at a disadvantage as compared with the pauper, the farmers refusing to employ those whom they were not compellable by law to support."

"The chief results of this system were the inducing of a well-nigh universal pauperism amongst the labouring classes, who became idle and dissolute in the extreme. Incendiarism and riot appeared to have followed in the train of idleness. In the year 1832, during "a period of great prosperity" says a centemporary writer. "we find that portion of England in which the Poor Laws had had their greatest operation, and in which by much the largest expenditure of Poor Rates had been made, the scene of daily riot and nightly incendiarism. Meanwhile the rates pressed so heavily upon the land, that in the year 1832 many thousands of acres had been thrown out of cultivation."

"The English Poor Law system of 1834 was adopted to counteract this state of things, &c.; and, upon the whole, has been a successful measure, though its efficiency has been greatly lessened by the want of intelligence in its administration. In some, if not in many instances, this has resulted in ill-judged parismony taking the place of ill-judged prodigality; and this unfair working of a general good measure has led to the recent workhouse disclosures, with their consequent excitement and disgust."

It is indeed evident that the absence of proper supervision has been the most general cause of whatever degree of failure has arisen in the working of the English Poor Laws.

Until the near 1819 no attempt appears to have been made in this colony (probably it was not required) to provide a systematic relief to the poor and destitute, the British Government contenting itself with the charge of such of the aged, indisposed, and decrepid convicts as were incapable of labour and unfit for the *prison.* At this period, however, distress and suffering seem to have made themselves evident to the hearts of certain philanthropic gentlemen, who, with the sanction and warm-hearted co-, operation of Governor Macquarie, established the "Sydney Benevolent Society," the object of which was, "To relieve the poor,

the distressed, the aged, and the infirm, and thereby to discountenance as much as possible mendicity, and vagrancy, and to encourage industrious habits amongst the indigent poor, as well as to afford them religious instruction and consolation in their distresses." As the history of this society is that of Poor Law relief in New South Wales, for a period of more than forty years, I will mention such of its features as appear calculated to trace its character and progress. During the first three years of its existence it was supported solely by private contribution and confined its labours to the distribution of outdoor relief. In the third year Governor Macquarie erected the *front* of the present structure, affording accommodation for sixty inmates. He futher furnished it, and provided the salaries and rations for the master and matron, directing also that all inmates, who might be considered as chargeable to the Crown, should be victualled from his Majesty's Stores. The first inmates consisted of nineteen persons, who had previously been outdoor "*pensioners*," but within a few months 48 men and 9 women had been received, who are described in the report as "consisting generally of persons who were more or less blind, bedridden, paralysed, or palsied," their ages varying from 50 years upwards, but the majority being very aged. About the year 1830, it became necessary to provide additional accommodation, and this was done at the expense of Government by the erection of the north wing.

About the year 1840 the society received from the hands of the Government the building at Liverpool, previously used as a convict hospital. This they immediately occupied.

In 1862 it became necessary to add to the accommodation of the Liverpool Asylum.

In 1864 the Government erected three additional wards at the Sydney establishment to meet the steadily increasing demands upon it.

In 1863, the establishments under the control of the directors of the Benevolent Asylum had become so much crowded, and the society dependent upon the Government for such large annual votes of money (£11,916), that a Committee of the Legislative Assembly was appointed to inquire into the subject—the result of which was, that the Government relieved the directors of the charge of the aged and infirm, and took the Liverpool Asylum into its hands—leaving the establishment at the Haymarket under the control of the directors, who were requested at the same time to receive, as inmates, only lying-in women, and destitute women with children, but to continue their duties as the distributors of outdoor relief. It was also arranged that the Government should be responsible for the entire support of the inmates, and that it would add a sum not exceeding £500 to the annual subscriptions to be devoted to out-door relief. This

arrangement still continues. I append a table showing the annual income and expenditure; in reference to which I need only observe that up to December, 1862, the total receipts of the society had amounted to £205,113, of which £44,982 had been received from the military chest, £117,209 from the Colonial Government, and £42,921 from private subscriptions. The total amount expended in outdoor relief had been £31,080. If we now turn to the principles upon which this society has been conducted, we find that while it received these large votes of money as the sole representative of Poor Law relief, it was conducted upon the principle of *charity*—in other words, the Government handed up during a period of thirty-nine years no less a sum than £162,191 as its Poor Law expenditure, to a society of gentlemen, who acted entirely under the influence of *charity*, and not in accordance with the principles supposed to be required in the administration of Poor Law relief. Thus we find in the second report that the Committee purchased a wheelbarrow and a boat for a poor man, at the cost of about (£16) sixteen pounds, which it was supposed he would repay. Again, in the report for the year 1823, we read as follows:—

"Two cases of this nature occurred during the last year. A poor aged man, *nearly* destitute, and unable to help himself. The Committee assisted him with a wheelbarrow and an axe; since which the man has been able to provide for himself, without being any further charge to the society. Also, a man with a sickly wife and three children, being obliged to pay out of his small earnings, for the hire of a boat, 5s. or 6s. weekly. The Committee purchased one for him for forty-eight dollars, and he repays very punctually *one dollar per week*, by which means the boat will soon become his own property."

The same report closes with the expressiou of an earnest hope that Christianity may produce more abundant proofs in New South Wales, &c.

These extracts will suffice to indicate the spirit of benevolent *charity*, under the influence of which the directors acted; while the large sums of money with which they were entrusted affords ample proof of the confidence placed in them by the public and the Government, as well as of the heavy responsibility and labour attending the performance of their duties. One feature in the appended table demands especial notice. During the first two years, the private subscriptions flourished well, but as soon as the Government commenced its assistance, they fell seriously off. Making every allowance for the excitement under which most charities are established, it appears that the subscribers felt materially relieved of their responsibility when the Government lent its aid. This spirit is most ingenuously expressed in a report of the society for 1825, which naively commences by

stating, that although the treasurers were without any funds, and considerable debts were owing at the beginning of the year, the directors did not contemplate any serious difficulty. The report then proceeds to acknowledge the great kindness of his Excellency the Governor whenever they were compelled to submit a statement of the society's affairs to him, and to state that in reply to such applications at various times he gave them, during the year, the respective sums of £150, £500, £200, and £400.

The present objects of the Benevloent Society remain the same, according to the reports, as at its inauguration, but the demand upon the special forms of relief to which it is now confined continues to increase. Thus, the report for 1867 states that "121 women were safely accouched (of whom no less than 77 were unmarried)," and "that the increasing number of children in the institution became once more a subject of great anxiety to your committee. In accordance with their recommendation, and with the sanction of the Government, 93 children were transferred to the institution at Randwick."

In taking the care of the infirm and aged into its charge, the Government accepted the important responsibility of initiating a national system of Poor Law relief, and the first step adopted was the appointment of a Board of Management and Control. This consists at the present time of three gentlemen, whose services are gratuitous and who meet twice a week.

Immediately after their appointment they appropriated the Liverpool Asylum to the reception of males and the Hyde Park Barracks to females; but the rapidly increasing number of applicants soon necessitated additional accommodation.

In June, 1866, a building was fitted up at Port Macquarie, and during the present year an additional wing has been added to the Liverpool Asylum.

In 1863, the daily average of inmates in the various as ylums under the control of this Board was 624. Upon the 30th June in the present year it was 1041, showing an increase of 417 in 4½ years.

It should, however, be mentioned that many persons find their way to these asylums from the neighbouring colonies.

The total cost per head per annum, inclusive of salaries, &c., is—at Liverpool, £12 18s. 9½d; Sydney, £14 4s. 11d.; Parramatta, £14 6s. 1d. giving an average of £14 1s. 11¼d

These figures speak for themselves and prove that the principles of "necessity of relief," with rigid economy, are accepted, At the same time, it is evident to those who visit these institutions that necessary comforts are provided. Indeed, their management reflects credit alike upon the zeal and humanity of the Board.

It appears, however, that beyond those above mentioned no principles have been laid down for providing further accommodation; and that the time has arrived when the existing hand to mouth system must give place to a broader and more expansive scheme.

At present the Board labour on, doing what good they can with the very insufficient means at their disposal. When the existing asylums have arrived at the extreme limit of overcrowding, either some additional old building is sought for, or a wing is attached somewhere.

Thus it is that they are compelled to place the aged and infirm women (many of whom are of great respectability) in a huge, ugly, three-storied building, enclosed within walls fifteen feet high, and having a lilliputian verandah at one end only, possessing but a few square yards of ground; and last, though not least in the category of absurd evils, situated in the heart of the city. Other paupers are dispatched to a distant port, so far removed as to be beyond the inspection of the Managing Board, and to impart a strong sense of transportation to the emigrants.

The circumstances of the colony and action of the Government have developed other institutions bearing more or less upon Poor Law relief.

Four local benevolent asylums exist, one at Penrith, Scone, Singleton, Cooma, and Windsor. The number of inmates contained in them on 31st December, 1867, was ninety (90), and the cost to Government for the same year was £912.

They are not under the control of the Central Board.

Other country hospitals receive a certain proportion of infirm and destitute persons, but I am not aware that any definite laws exist for their management in reference to the admission of this class of inmates.

A considerable number of them are in a woful state of repair and poverty.

The Destitute Children's Asylum had in December, 1867, after but a few years' existence, the enormous number of 682 inmates, and received from the Government no less a sum than £8689 during the same year.

At the same date (December, 1867) four other schools which are *entirely* dependent upon Government support contained an aggregate number of 637 children.

The Sydney Infirmary may be said to contain 200 beds, and admitted during the year 1867 1708 patients. The Directors are bound by an agreement with the Government to receive, as qualified applicants for admission, all persons presenting an order from the Colonial Secretary's Office; and for such actually admitted the Government pay the institution one shilling and tenpence per diem, in addition to other considerable grants, which,

from 1850 to 1867, amounted to £13,287. This system of Colonial Secretary's orders appears to have originated in circumstances, when the Infirmary was a refuge for the infirm and aged and those suffering from incurable chronic disease; but it is an undesirable arrangement in the present state of the population, and is detrimental to the character of the hospital which is at present devoted by the Directors to the treatment of cases of acute and serious disease and accident. It is one also which is, as might be expected, greatly abused. For instance, I find that during the present year persons have *obtained admission* upon the Colonial Secretary's order, upon whom the following sums of money have been found:—

1 patient had £170, 1 patient had £193.
1 patient had £78, and 1 patient had £215.

Considering the *large* number who are unable to gain admission, and that many are in the habit of placing their money in safe keeping, to render themselves qualified as applicants, it may be presumed that a great many accept the boon thus so freely offered, and, by so doing, not only lose that spirit of independence which it should be the ambition of a Legislature to foster, but entail a serious injustice upon their poorer brethren, who are necessarily turned away from want of room.

The average cost of each patient in the Infirmary is at present two shillings aud eightpence per diem.

Two *Lunatic Asylums* exist, which are supported at the public expense: they contain all the insane in the colony, except ten, who are inmates of Mr. Tucker's private establishment at Cook's River. The patients necessarily consist of members of all classes in society, high and low, rich and poor, those accustomed to the luxuries of well-appointed homes and the comforts of family associations, together with the gutter drunkard, and the obscene, blasphemous, maniac, &c.

Owing to the want of space for due classification and an absence of the arrangements of a modern hospital for the cure of insanity, all these are mingled together to a degree which is most painful to witness. Of the 1155 inmates of these public asylums a few persons (not more than 25) *are supposed* to pay the Government at the rate of 2s. 2d. per diem.

The husband of one of these patients died a few days since, leaving as I am informed, available property to the amount of £110,000. I am glad to be able to add, that the late Government adopted the wise course of sending a fully qualified commissioner to Europe and America, with instructions to visit the lunatic asylums and report upon their construction and management. This report has just been printed and laid before the Legislature. It contains a vast amount of most valuable information that cannot fail in being useful, not to this colony alone,

but to all who desire to promote the comforts and well-being of the insane and advance Pyschological Science. The consideration of this document, and the development of a well-matured scheme for the treatment and cure of the insane in the colony, must of necessity occupy a considerable time; but, in the meanwhile, the present Government appears anxious to diminish the most pressing exils, and is at present engaged in relieving to some extent the very serious and overcrowded condition of the public establishments.

The number of charitable institutions not mentioned above, but which also receive aid from the Government, is thirty-four.

The number of inmates which they contained in December, 1867, was 261; and the aggregate amount received by them during the same year was £7877; the aggregate amount received by them from private contributions during the same time being £8556.

The number of persons in all the institutions, charitable, benevolent, and reformatory, which receive whole or partial Government support, was, upon the 31st December, 1867, 4076, or 1 to every 110 of the population.

The number of persons for whom provision was made in the Benevolent Asylums, during the year 1867 was 3277, or 1 to every 137 of the population.

The number of children in establishments wholly or principally supported by the Government was, at the above date, 1269, or 1 to every 353 persons.

In 1867 an Inspector of Charities was appointed by the Government, whose duty it is to visit all charitable institutions receiving aid from the Government, and report upon their management, &c.

If we now turn to the reports of the Poor Law Commissionsrs of Great Britain for 1866. We find that in 1865 (I take this year as the latest I can obtain statistics of) the total expenditure in England and Wales for Poor Law relief was £6,264,961, or at the rate of 6s. per head of the population.

The total expenditure for the same purpose in New South Wales for the year 1867 was £88,139, or at the rate of 3s. 11¼d. per head of the population.

The difference between the two expenditures being, that in New South Wales it includes the Government subscription to charities, and does not include relief to able-bodied adult paupers

The mean number of all classes of paupers in England and Wales, exclusive of able-bodied adults, receiving indoor relief, at one time was, at Lady's Day, 1865, 111,494, or 1 to every 187 of the population.

The paupers in New South Wales, calculated by the number of inmates in Benevolent Asylums, Destitute Children's Asylum, and other Schools, was, upon the 31st December, 1867, 2538, or 1 to every 176 of the population.

I will now briefly allude to the question of relief to able-bodied adults in health. Referring to the Registrar's statistics for 1867, we find that the lowest rate of wages for mechanics is quoted at 8s. per diem, or £50 per annum, exclusive of board and lodging; and that the average rate for the last four yeurs has been nine shillings per diem, or £75 per annum, exclusive of board and lodging. That the lowest rate for farm labourers and shepherds was £28, per annum, exclusive of board and lodging; the average for farm labourers having been £29, and the average for shepherds, £32. For female servants the lowest quoted rate was £15 per annum, exclusive of board and lodging; and the average was £21. I believe I am correct in judging that bread, tea, sugar, and common groceries, taken in the aggregate, may be calculated at nearly the same price in New South Wales as they are in Great Britain; and that the price of meat has ranged in New South Wales at from one-third to one-fourth of its retail price in Great Britain. Finally, I am informed that a large amount of capital, during the last few years, remained idle, in consequence of the high range of wages, rendering its employment unprofitable. If these data are correct, it must be allowed that no *necessity* can exist at present for granting Poor Law relief to this class; and this being the case, it will be evident that any such aid would, if granted, be unjust to the taxpayer, injurious to the community, and destructive to the independence, industrial habits, and self-reliance of the persons relieved.

We have now to ascertain, as far as possible, if the numerical increase of the true pauper class is. or is not, out of proportion to the population and circumstances of the colony.

The records of the Immigration department show that from 1st January, 1838, to 31st December, 1867, the number of persons who landed in the colony, being above twelve years of age, was 111,180. The influx of adult life represented by these figures *has* probably had its influence in yielding a disproportionate number of aged and infirm. It is true that the more favoured condition of New South Wales, in comparison with Great Britain, amply compensates for this result; but it must also be borne in mind that, while the advantages enjoyed by the colony undoubtedly tend to the material prosperity of the large proportion of immigrants, the special features of the country, unfortunately favour the growth of pauperism and dependence among those possessing impaired health, diminished energy, sensual dispositions, or idle habits. To such, the absence of family ties and associations, the uncertain character of the occupation, the gam-

bling nature of the digger's hopes and labour, the dull monotony of the shepherd's life, the uncertainty of the seasons, the heat of the climate with its accompanying temptations, and the solitude of country life, all these must, and do, injuriously affect a certain proportion of average humanity, producing pauperism in its true sense, as well as "pauperism" arising from chronic illness and infirmity. Recent experience, has, however, brought to light another source, in the fencing in of runs, by which many aged hutkeepers and shepherds, capable of no other labour, have been thrown out of employment into the Government Asylums.* On the other hand, it may reasonably be expected that, as the colony becomes more settled in its pursuits, family ties will be stronger, and the disposition to support aged relations greater. Upon the whole I conclude that the rate of increase of this class has been disproportionately large of late years, and that, although the numbers must continue to rise, they will not in future be likely to do so in quite the same large proportion to the population. Somewhat similar reasons appear to have stimulated the numbers of destitute children. It is notorious that during the gold mania the diggings and accompanying excitements induced many men to desert their wives, and many mothers their children; while the readiness with which Charity and Pity accepted the charge of the infants thus deserted, became in its turn an excuse to some in whom parental affection was weak, to relieve themselves of the trouble and expense of those whom nature had bestowed upon them to support and caress. It may be hoped, therefore, that a more settled character of employment, together with the greatest firmness and discrimination on the part of the directors of our industrial schools and reformatories, will ere long diminish the hitherto enormous proportion of destitute children, if not the actual numbers in the establishment. The third class would not demand space in a paper devoted to Poor Law relief, but for the peculiar circumstances of the colony, which render it difficult, if not impossible, for a person afflicted with incurable disease to obtain support except at the hands of Government or Charity. My own experience indicates that many of the most pitiable cases of suffering and poverty occur among this class. The general activity of life, the limited nature of the homes of the hand-working class, and in many instances, the absence of family ties, often leave them shelterless and friendless. There appears little hope, therefore, that any diminution will take place in this class; it is more probable that increase of population will more than counterbalance past and temporary influences.

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* In one Station, upon which a large portion of land has recently been fenced in, the number of hands has already been reduced from two hundred (200) to thirty-three (33), and further reductions are to be made,—this may be accepted as an average instance.

In venturing to offer a few suggestions for modifying the existing system of administering Poor Law relief, I must crave the indulgence of the society, and remind them that I trust to the reflection and discussion which it is the object of this paper to originate, for any good that may arise from it.

1st. I would submit that the social and general circumstances of the colony require that all Poor Law relief should be founded upon the principle of *necessity* alone, that the period has arrived when the Government is called upon to accept the entire responsibility of its administration; and that this should be accomplished with the ultimate view of handing over a good system, in efficient, working order, to local administration and responsibility whenever such a course can be satisfactorily adopted.

2nd. That indigent sufferers from incurable disease should at once be included among the recipients of Poor Law relief.

3rd. That it is desirable to pass a law, to oblige children capable of supporting infirm parents to do so.

4th. That the existing system of using country hospitals, as hospitals and benevolent asylums at the same time, is unsatisfactory. it is subversive of efficient hospital management that cases of incurable disease, infirmity, or destitution should occupy beds in wards which are, or ought to be, devoted to the treatment and cure of disease. It is also undesirable that the ordinary inmates of a Benevolent Asylum should be exposed to the influences of disease more than is absolutely necessary.

5th. That all insane persons requiring seclusion within the public hospitals for lunatics, and possessing near relatives capable of supporting them, should be paid for in proportion to the means of such relations.

I have long entertained an opinion that the climate of New South Wales generally is favourable to health in advanced age; but to this end certain principles must be kept in view, which are simple and easily obtained. I allude to—abundance of fresh air, a simple and sufficiently nutritious diet, regularity of life and freedom from excitement. These should be considered the essentials; but it may be further accepted that no asylum for the infirm and aged should be placed within a city. Bearing in mind that we already possess an experienced Board of Management, I would suggest that the colony should be divided into certain districts, each of which might, at some future time, become responsible for the support of its aged and infirm poor. That from these a few should be chosen in the first instance, in each of which a suitable site would be selected for a benevolent asylum, which should be constructed upon a well-considered plan, designed by the architect of the Board and approved by the latter. These buildings should be occupied when finished to the relief of the existing over-crowded central asylums, as well as by such of the

inmates of the hospitals as may be suffering from incurable disease, permanent infirmity, and destitution from age. They should be under the control of the Central Board and managed by officers appointed by it, but supervised by a local Visiting Board appointed by the Colonial Secretary. Such of these asylums as it would be desirable to erect at once should be supported by the central Government until the colony is ripe for the inauguration of a general scheme of local responsibility in Poor Law relief, when they might be handed over to the local authorities to serve as models upon which other similar institutions should be constructed.

A deep sense of pride in the noble institutions which this colony has raised for the reception of its destitute, orphan, and depraved children, renders it difficult for me to express my views in regard to some of their features. But I would ask, if it is not possible that we may have accepted the charge of some children, the parents of whom might possibly have found, in the necessity for exerting themselves to support their offspring, the inducement to labour and steady habits. If this is not the case, where is this form of *charity* to end: already the number is enormous in proportion to the population, yet ever increasing. Nor does the evil stop here. What practical man expects children thus deserted, and subsequently reared with hundreds of other similarly placed, to possess the favouring influences which the associations of family relations alone can give, or that they will hereafter value their own family ties. Rather is it to be feared that they may produce food for the asylums which sheltered them. Industrial pursuits are, I am aware, now being fostered by the managing Boards of some of these institutions; and there can be no doubt but that exactly in proportion to the self-supporting power of the establishments will be the usefulness and success in life of their individual members. To those interested in this subject, I would strongly recommend the perusal of a small book, published at the public printing-office, and entitled "Reformatories in France." It contains a vast amount of useful and instructive information founded upon experience.

The third class, namely, those rendered destitute by chronic or incurable disease, are at present totally unprovided for by any system. But too often these sufferers pass from the hospital to the asylum, and *vice versa*, unable to gain admission. The hospital has not the accommodation for them, and the Board cannot receive them because the asylums are not hospitals.

They should be provided for in a healthy country locality; and as they require similar accommodation simple dietary and attendance to those of the "first class," they should be sent to the same localities, though into separate buildings.

Having, however, spoken of the urgent necessity of immediately providing for this class away from the city, in a former paper, I will not now trouble you with more than this cursory allusion to it, and an expression of my conviction that no class of sufferers have a more urgent claim upon the Government.